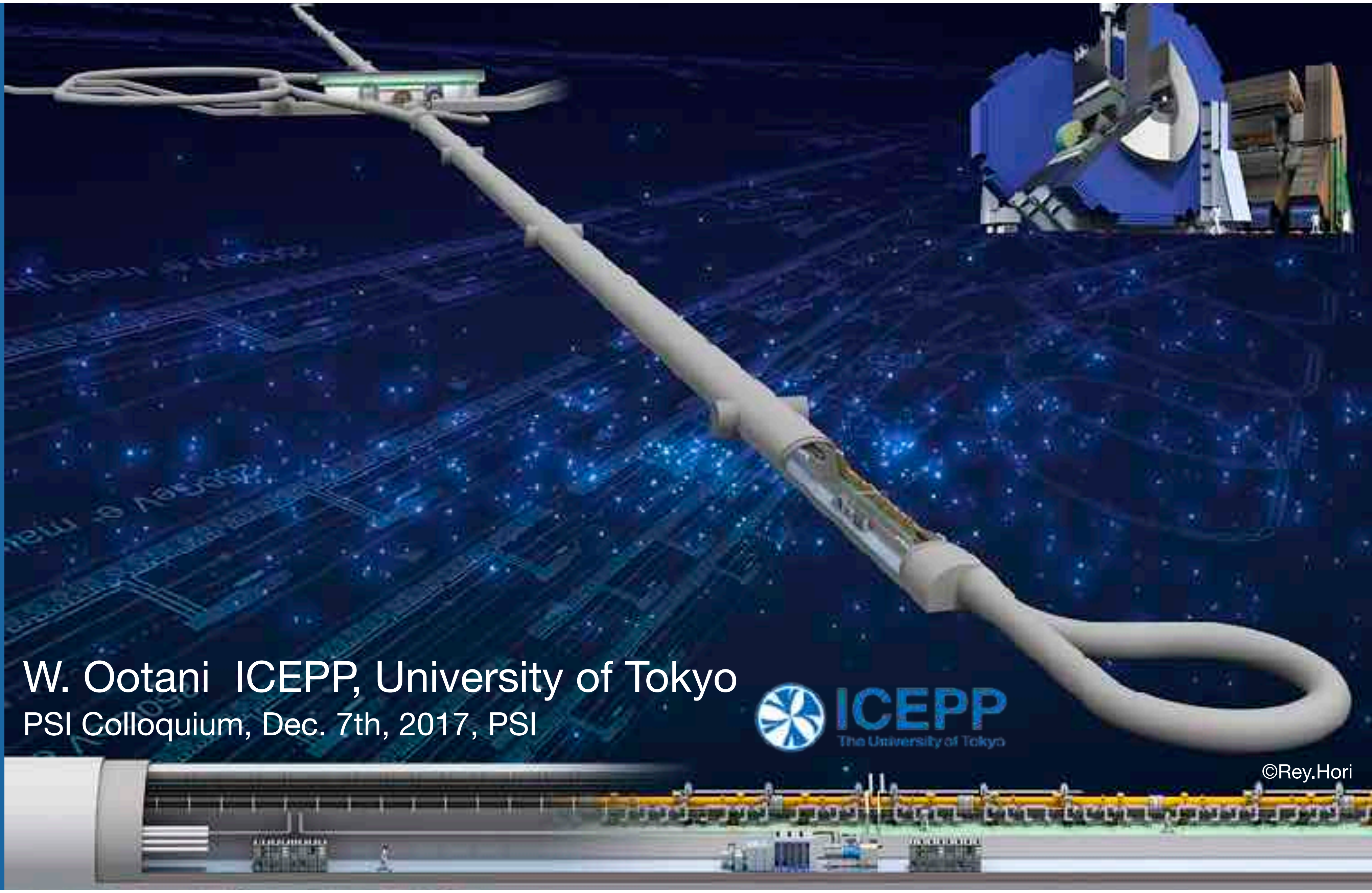
International Linear Collider (ILC)

Project Status and Plan

- Introduction
- Key Technologies for ILC
- Physics Case for ILC
- Status and Plan
- Summary



W. Ootani ICEPP, University of Tokyo

PSI Colloquium, Dec. 7th, 2017, PSI

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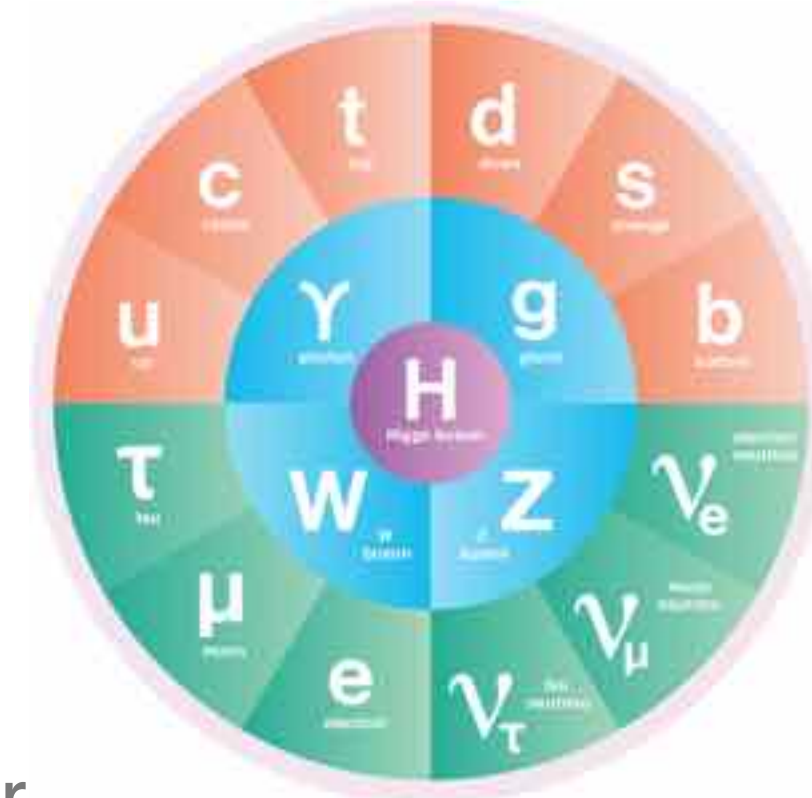
Triumph of Standard Model

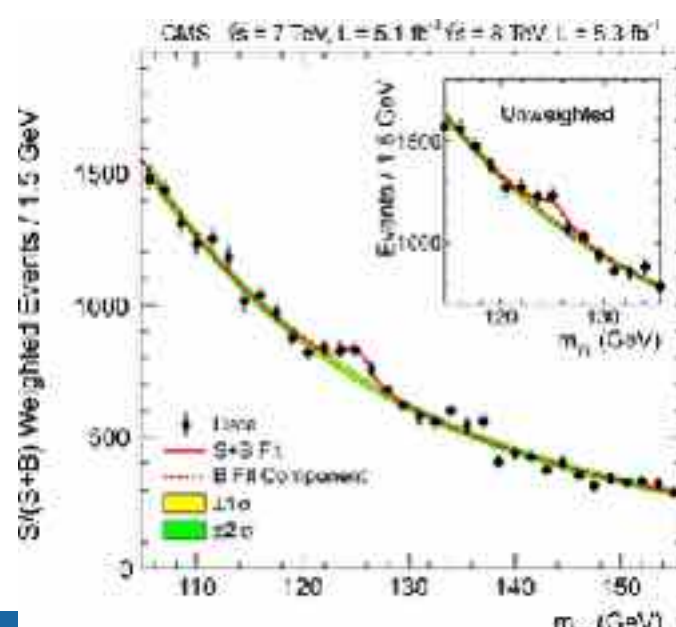
- **Discovery of Higgs boson as the last building block in the Standard Model**

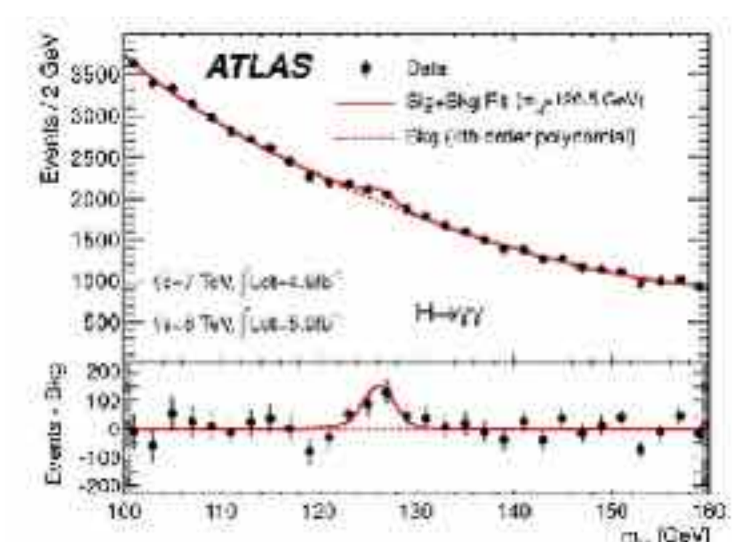
- **… still so many questions to which SM cannot answer**
  - Mechanism behind electroweak symmetry breaking
  - Dark matter
  - Neutrino mass
  - Matter-antimatter asymmetry in our universe
  - …

➡ **Need new physics beyond SM!**



symmetrymagazine.org





How to Explore New Physics?

- **Unfortunately, no signal of new physics found at LHC**
  - Energy scale of new physics is not known yet
  - No guarantee for direct production in colliders
- **Need alternative approaches to explore new physics including precision measurements to find a deviation from SM by exploiting existing probes;**
  - Higgs boson
  - Top quark
  - Electroweak bosons

→Lepton collider as a precision machine!

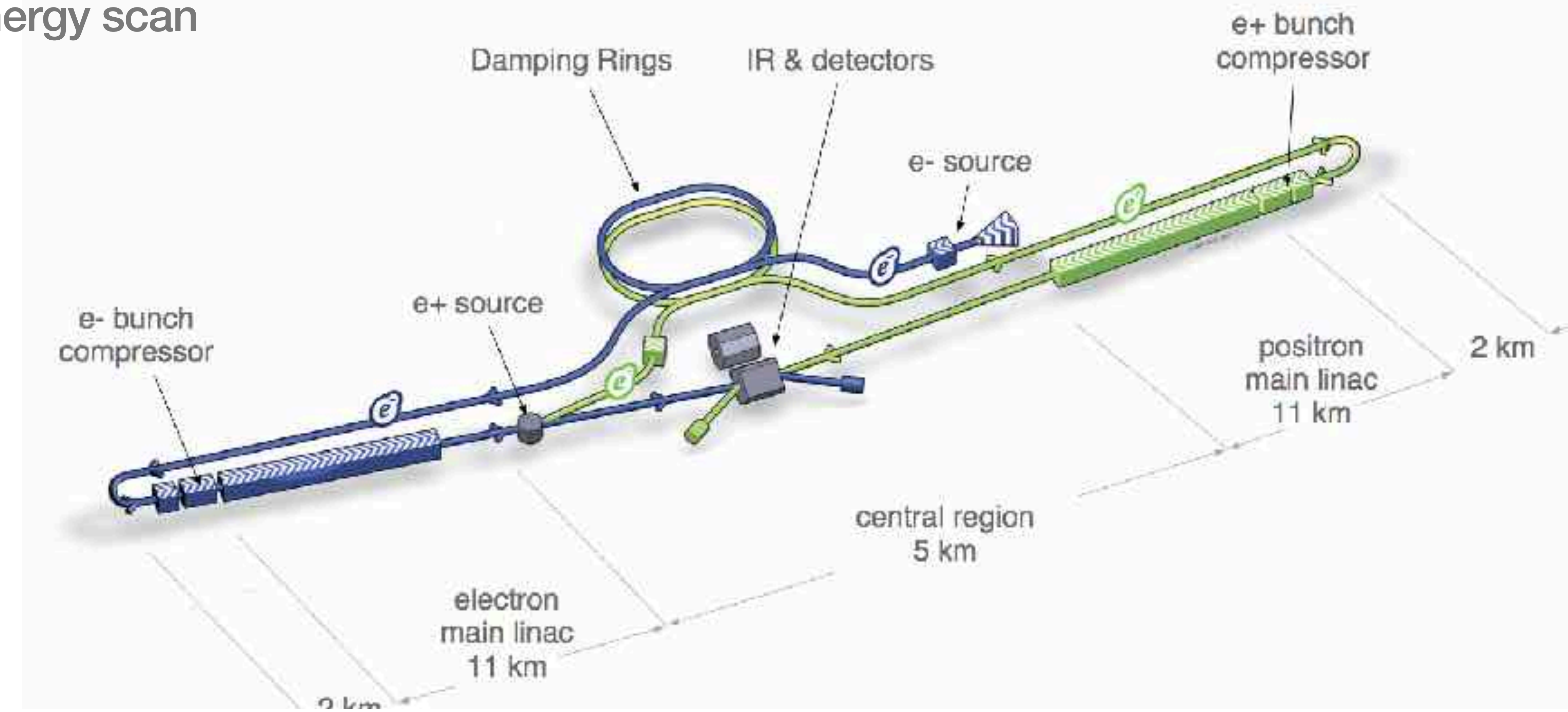
(would also work as a discovery machine for new particles)

ILC Project

- **International Linear Collider (ILC)**
  - Proposed ~31km electron-positron linear collider
  - Centre-of-mass energy: 200-500GeV (upgradable to 1TeV)
  - High precision studies in clean environment
  - Polarised electron/positron
  - Energy scan

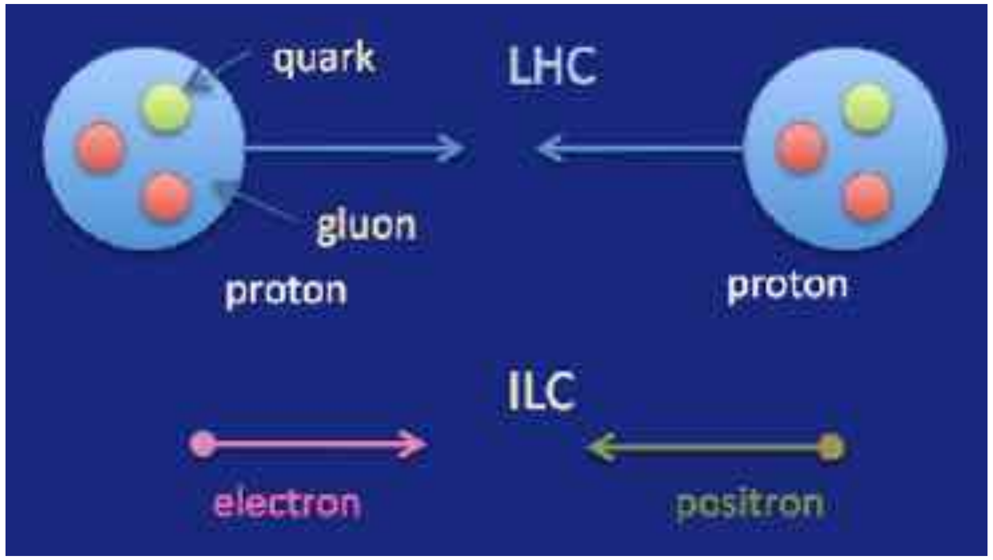
ILC baseline parameters

Parameters	Value
C.M. Energy	500 GeV
Peak luminosity	1.8 x10^{34} $cm^{-2}s^{-1}$
Beam Rep. rate	5 Hz
Pulse duration	0.73 ms
Average current	5.8 mA (in pulse)
FF beam size (y)	**5.9** nm
E gradient in SCRF	**31.5** MV/m +/-20%

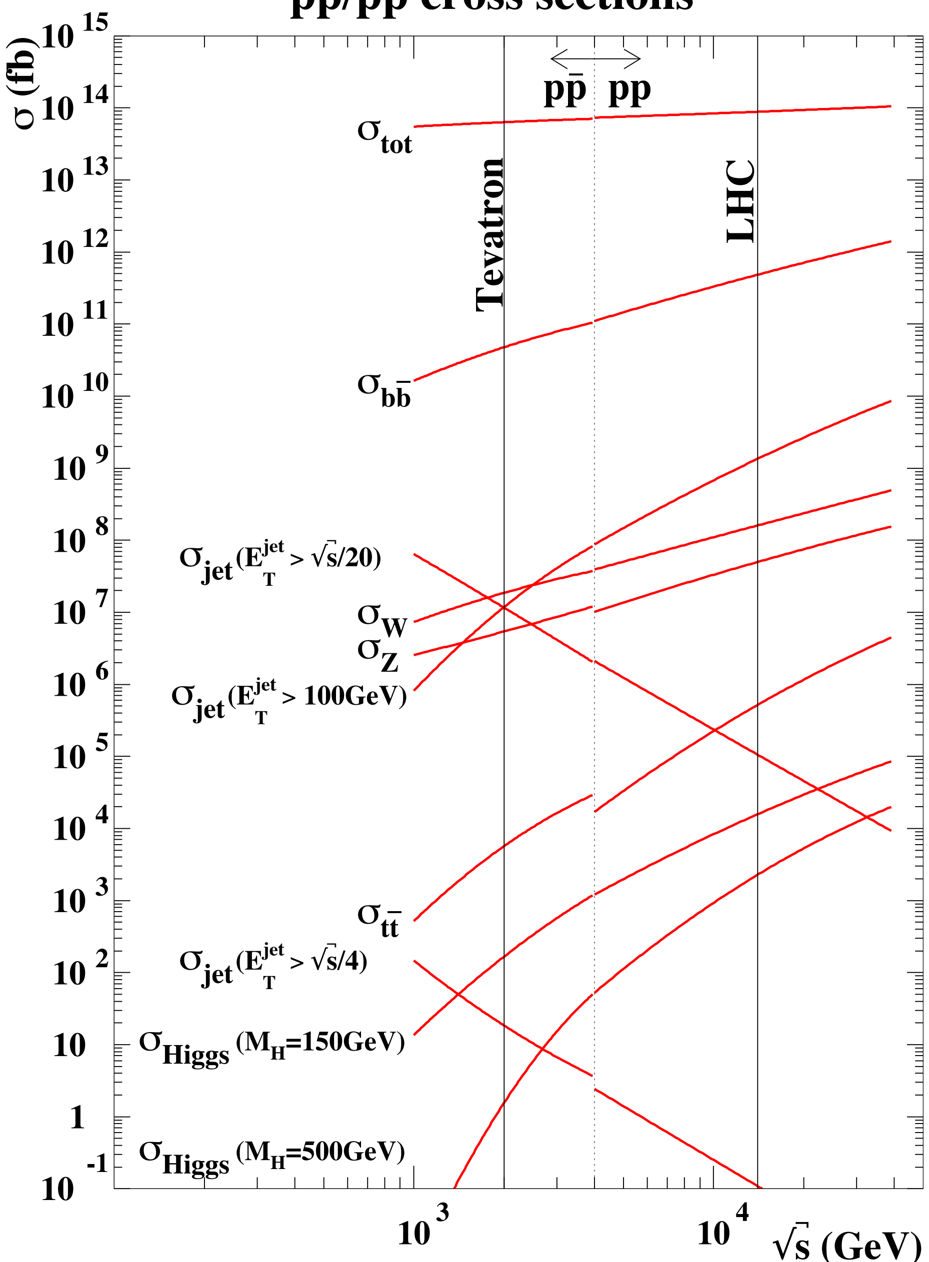


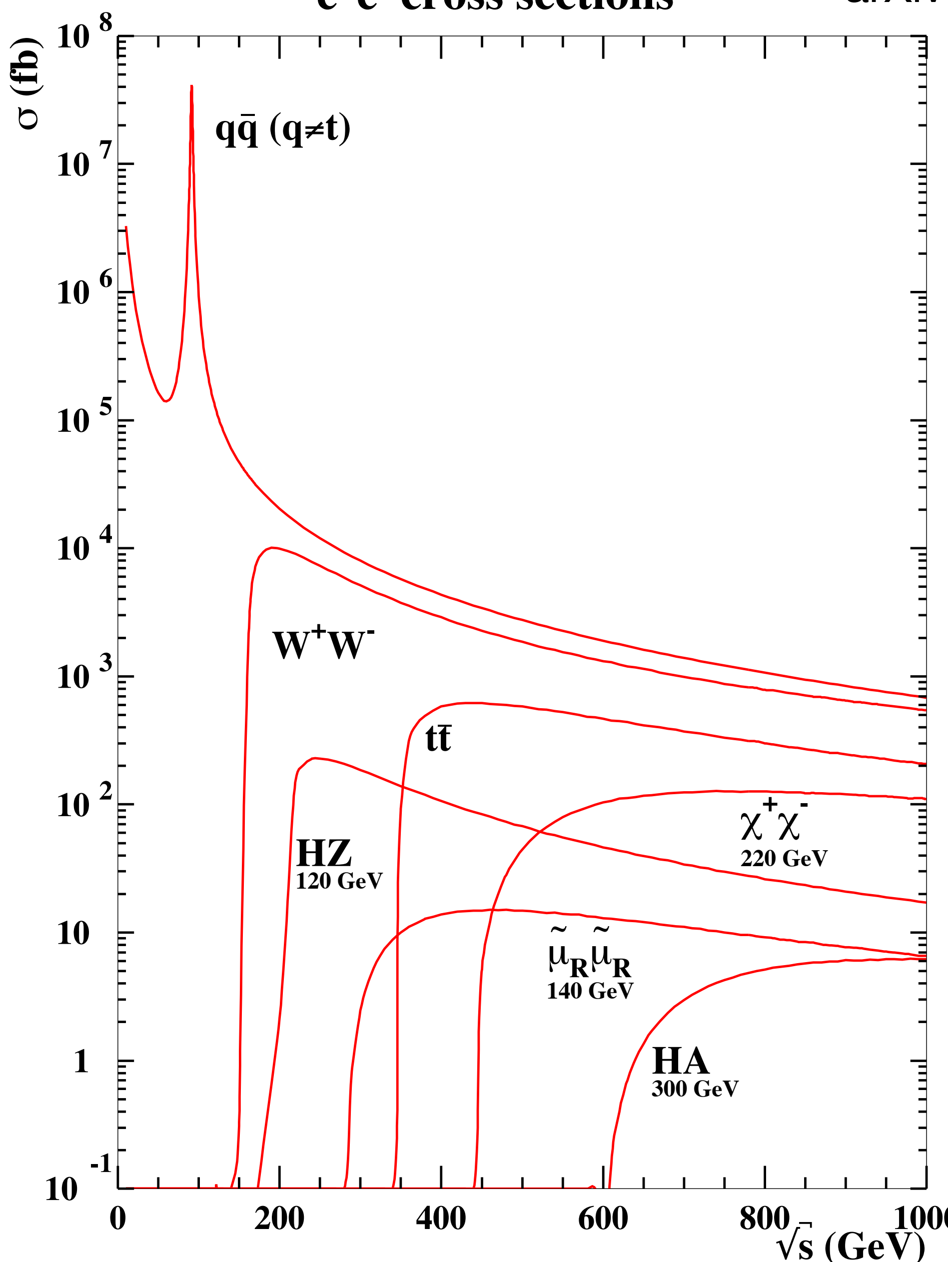
Why e+e-?

- Clean environment without QCD BG
- Well defined initial sates
- Direct observation of fundamental process
  - Looks as if Feynman diagram is directly observed!



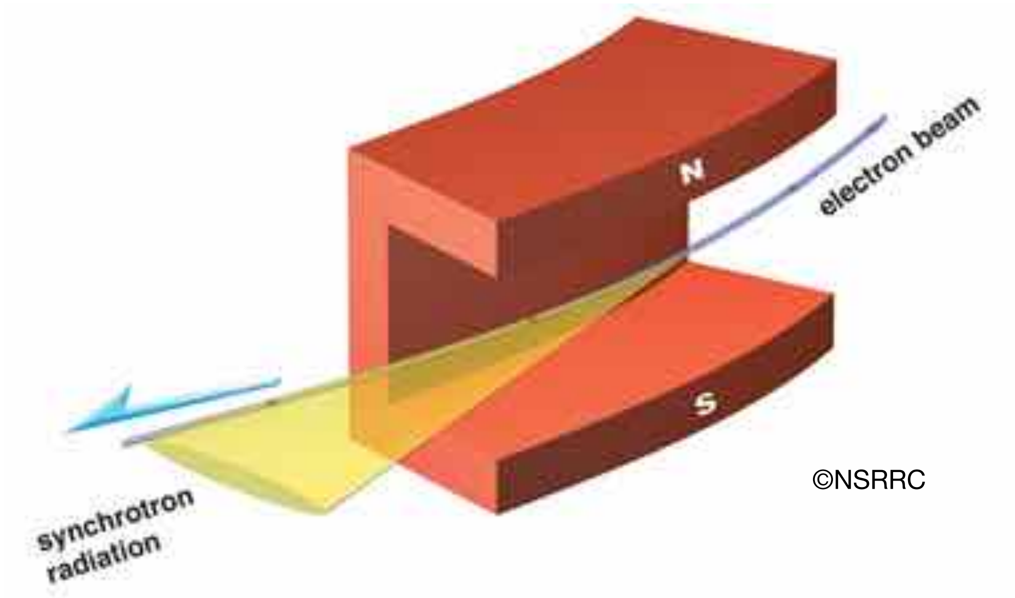
arXiv:hep-ph/0410364





Why Linear?

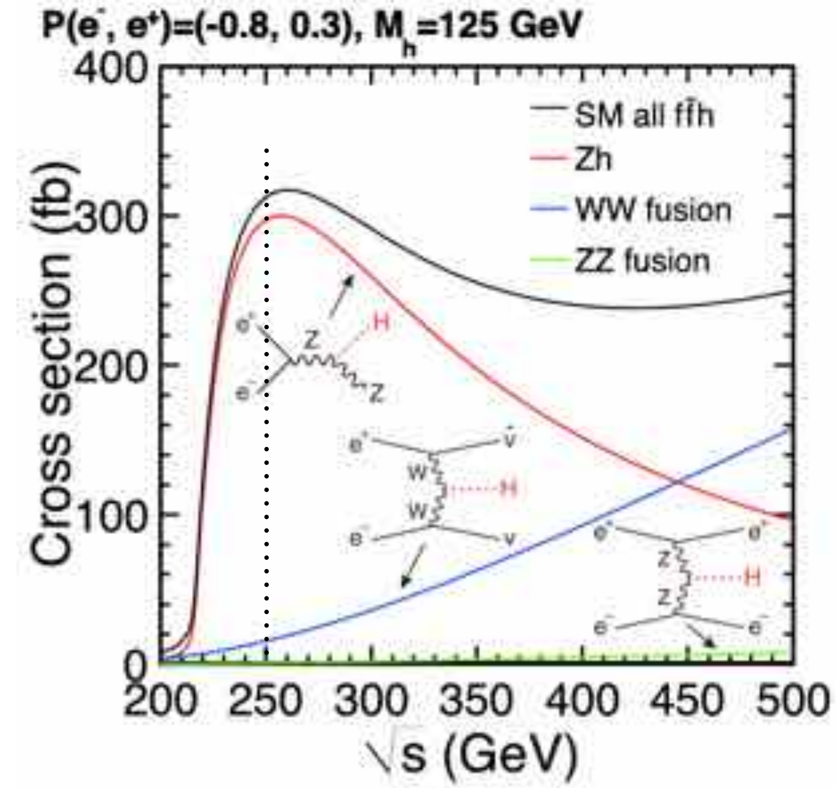
- **Limitation for circular lepton collider**
  - Huge energy loss due to synchrotron radiation
  - 250GeV loss for 210GeV (LEP)
- **Solutions**
  - Particle with larger mass → Hadron collider (LHC)
  - Larger R → Very expensive (FCC-ee)
  - Infinite R → Liner collider (ILC)
- **Advantages of linear collider**
  - Increase beam energy by extending linac length
  - Beam polarisation

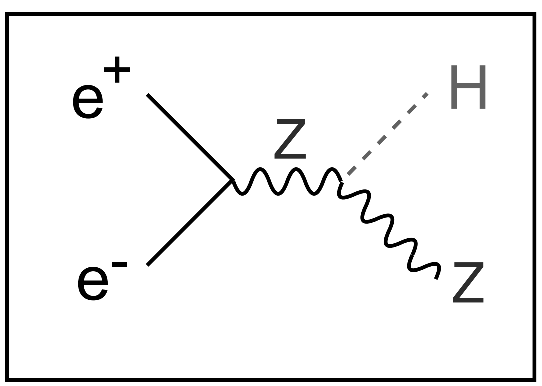


$$\Delta E \propto \frac{E^4}{m^4 R}$$

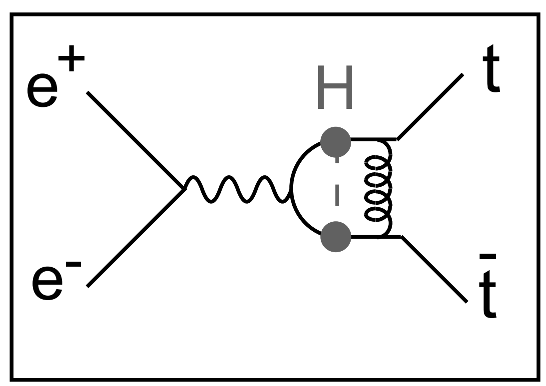
ILC Physics at Different Energies

- **Three important thresholds for centre-of-mass energy**
  - **250GeV:** Precision Higgs measurement with $e^+e^- \to Zh$
  - **350GeV:** Top physics with top pair production
  - **500GeV:** Higgs self-coupling with $e^+e^- \to Zhh/e^+e^- \to \nu\nu hh$
- **Discovery potential of new particles beyond SM at any energy**

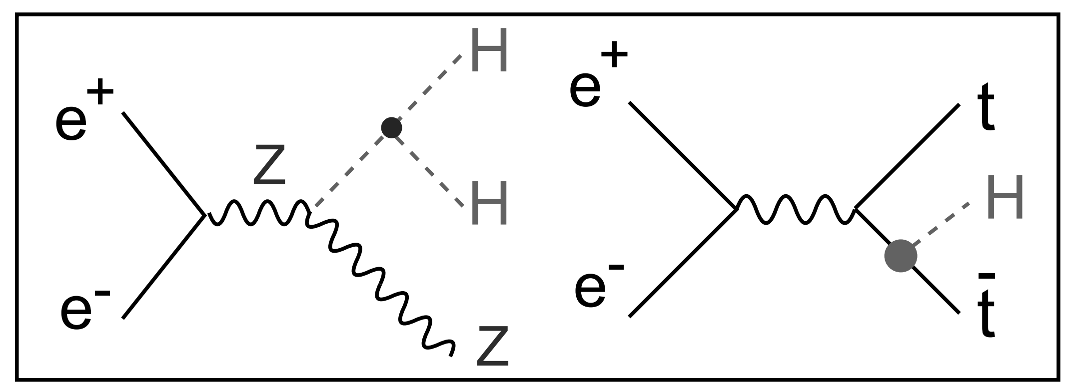




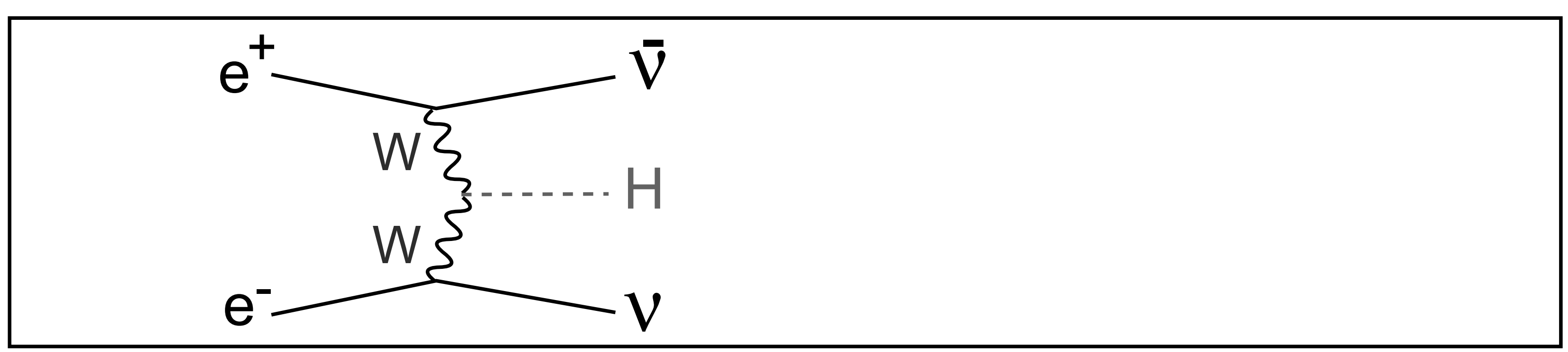
250 GeV



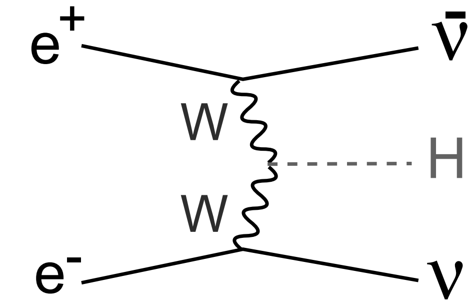
350 GeV



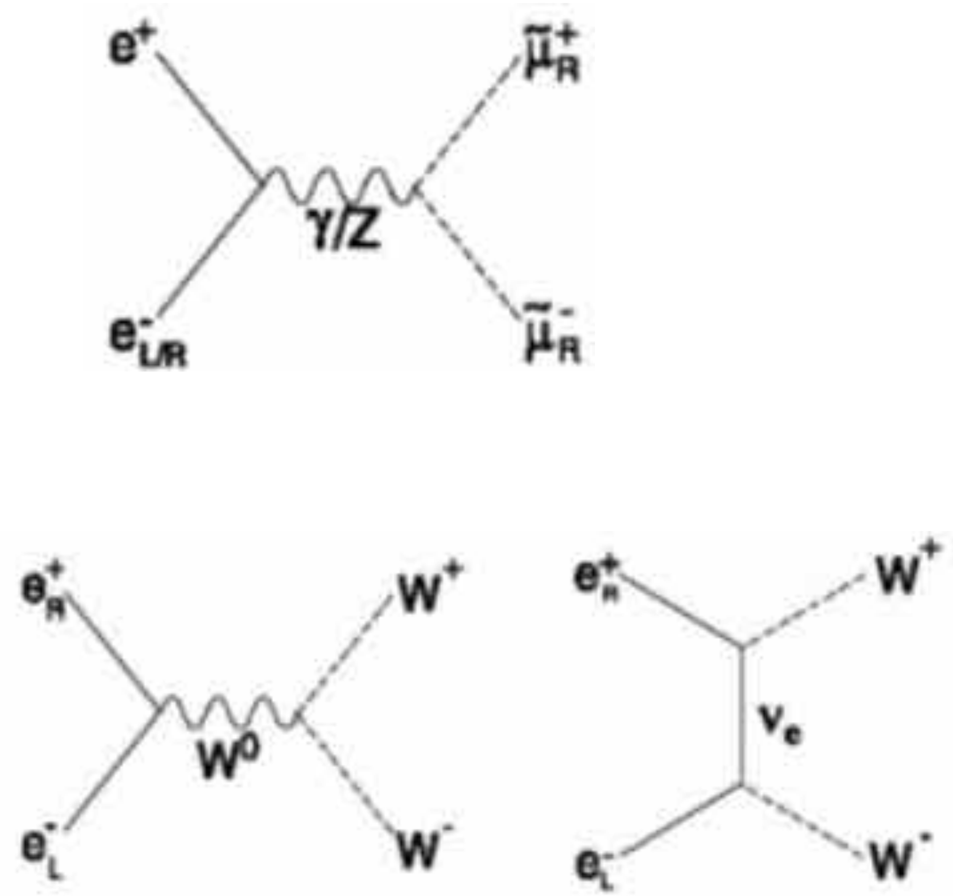
500 GeV

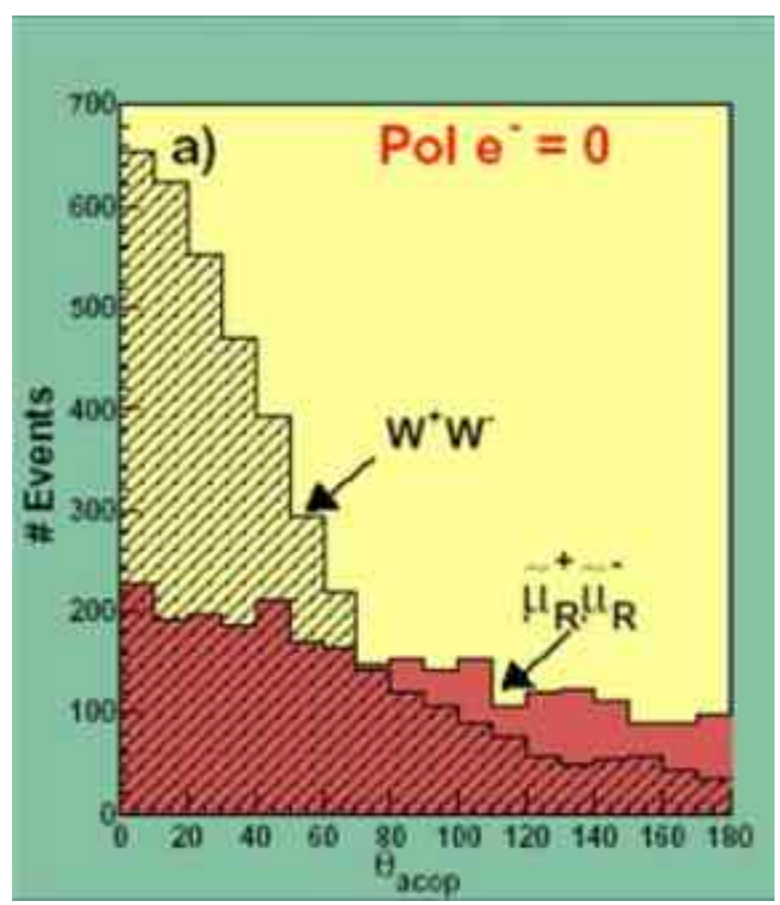


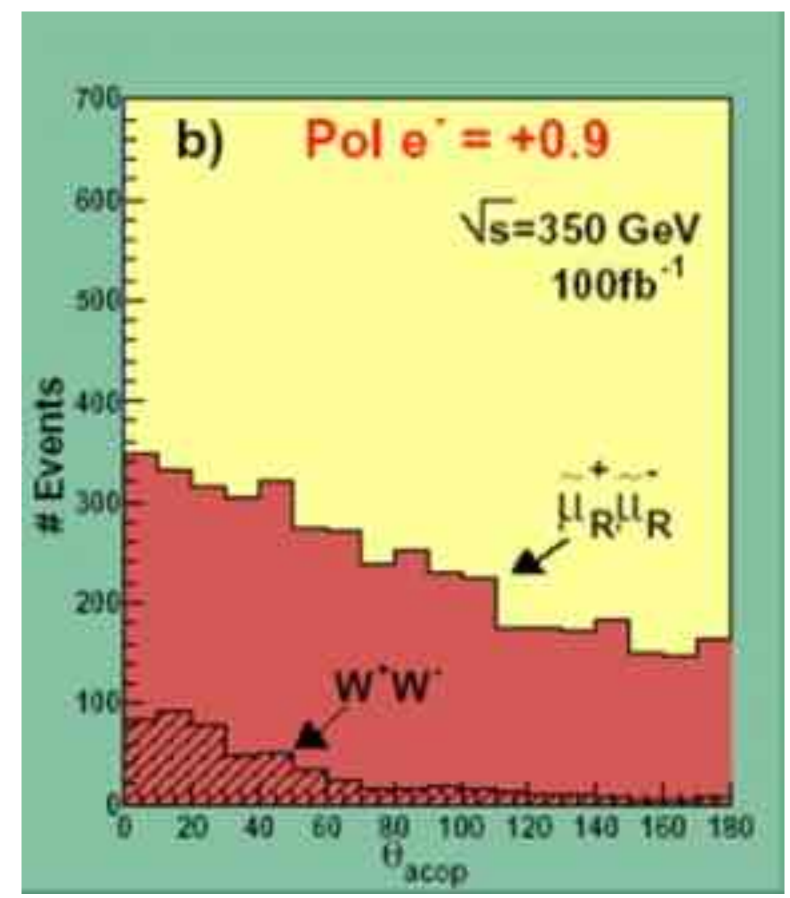
Power of Polarisation



- **Increase cross section**
  - Higgs production via ννH (VBF) is increased by ×2.34 for (e-, e+) + (-0.8, +0.3)
- **Background suppression**
  - Turn-off W with right-handed electron
- **Select intermediate state**







Global Organisation for ILC/CLIC

FALC
Chair: G. Blair
Funding Agencies for Large Colliders

ICFA
Chair: J. Mnich
International Committee For Future Accelerators

The ILC is a truly global project that ICFA is overseeing.

LCB
Chair: T. Nakada
Linear Collider Board 2012-

LCC organized in 2013
New 3-year mandate from 2017

KEK ILC Promotion Office

CLIC Collaboration

Public Relations

LCC
Linear Collider Collaboration

LCC Director
Lyn Evans

Deputy
Hitoshi Murayama

ILC
Associate Director:
Shin Michizono

CLIC
Associate Director:
Steinar Stapnes

Physics & Detectors
Associate Director:
Jim Brau

Statements from Japanese HEP Community in 2012

- **Statements from Japanese Association of High Energy Physicists (JAHEP)**
  - **In February 2012, in the final report of the subcommittee on future projects of high energy physics**

    "Should a new particle such as a Higgs boson with a mass below approximately 1 TeV be confirmed at LHC, Japan should take the leadership role in an early realization of an e^+e^- linear collider. In particular, if the particle is light, experiments at low collision energy should be started at the earliest possible time."

  - **In October 2012, right after the discovery of Higgs**
    - A Proposal for a Phased Execution of the International Linear Collider Project

Japanese HEP Community proposed to host ILC in Japan as a global project

Supports from the World

European Strategy approved by CERN Council, EC June 2013

Chair: Tatsuya Nakada (Swiss Federal Institute of Technology Lausanne)

e) There is a strong scientific case for an electron-positron collider, complementary to the LHC, that can study the properties of the Higgs boson and other particles with unprecedented precision and whose energy can be upgraded. The Technical Design Report of the International Linear Collider (ILC) has been completed, with large European participation. The initiative from the Japanese particle physics community to host the ILC in Japan is most welcome, and European groups are eager to participate. *Europe looks forward to a proposal from Japan to discuss a possible participation.*

Asia ACFA-HEP Statement on ILC

Chair: Mitsuaki Nozaki (KEK) July 2013

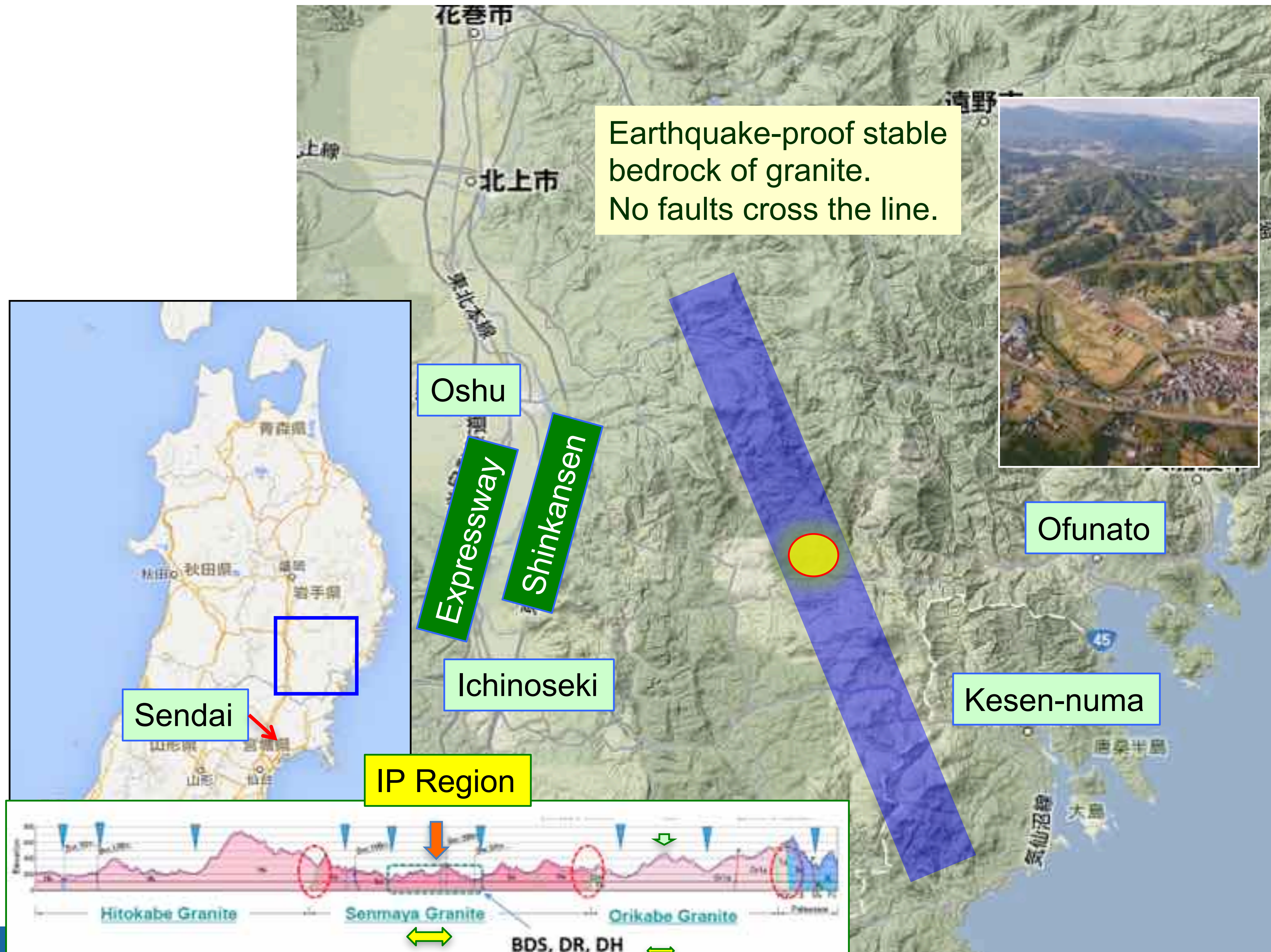
USA

Particle Physics Project Prioritization Panel (P5) Report, May 2014
Chair: Steve Ritz (UC Santa Cruz)

Courtesy of K. Kawagoe

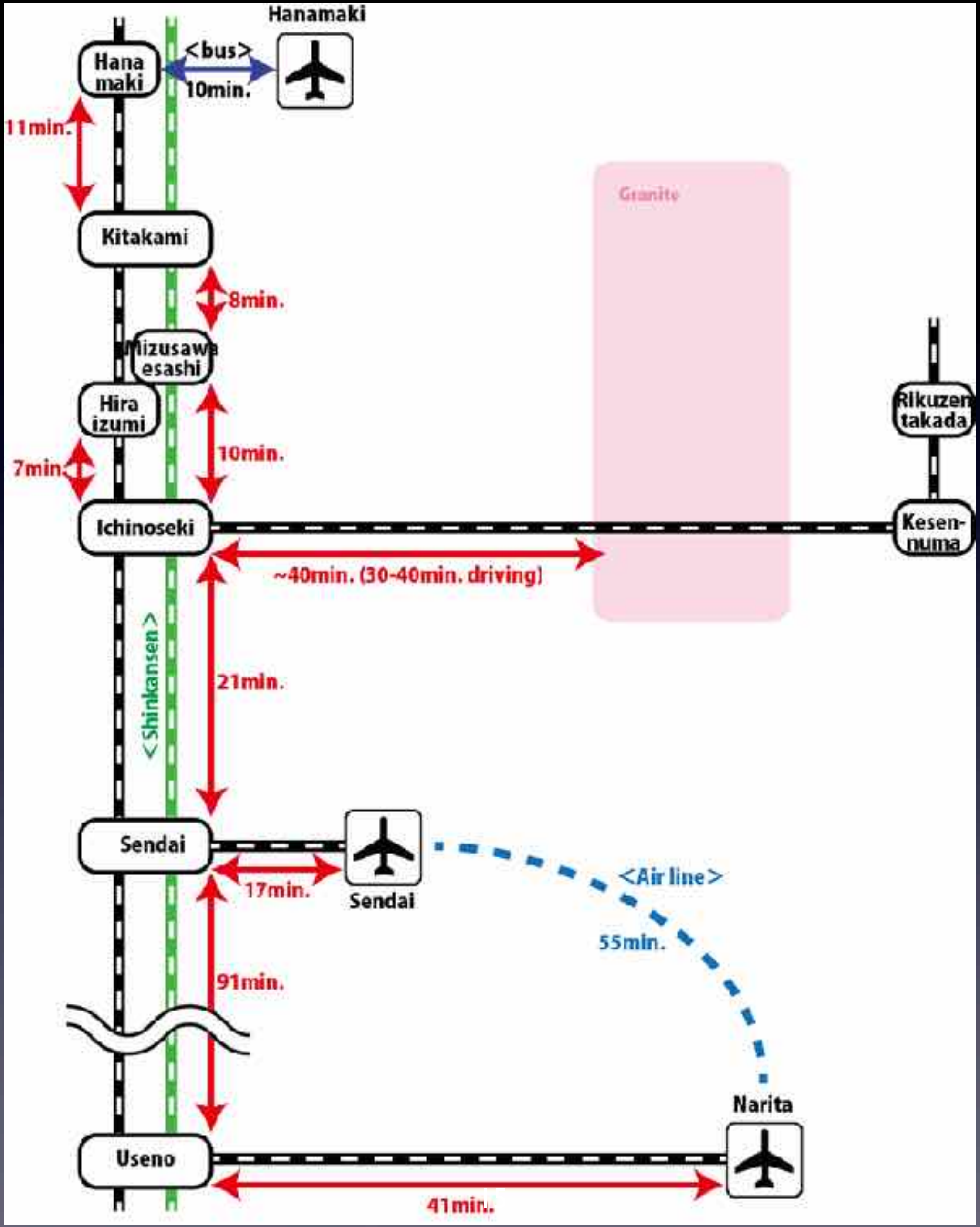
Candidate Site in Japan

- **Kitakami-mountain in north of main island of Japan**
- Site-specific machine design is being developed



central area (~10km away)

Courtesy of T. Sanuki



Courtesy of T. Sanuki

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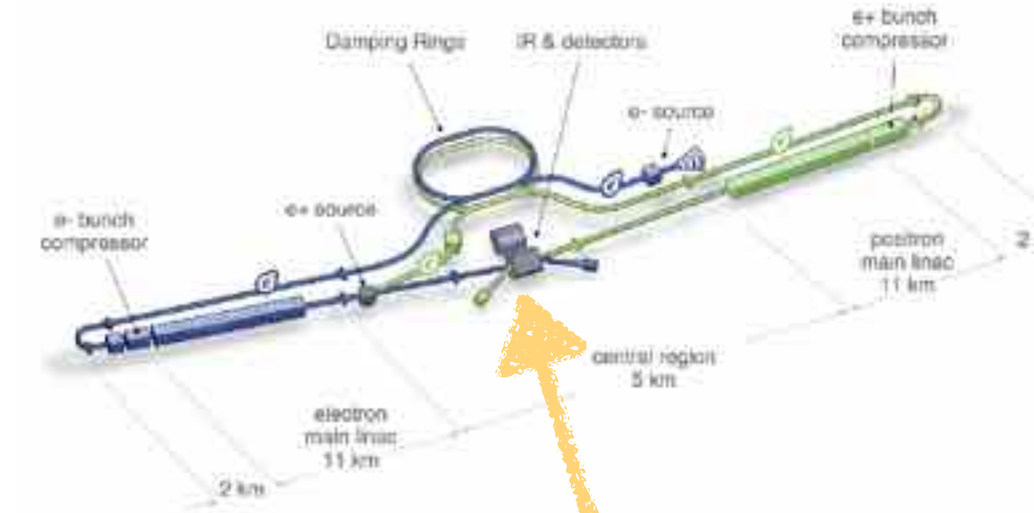
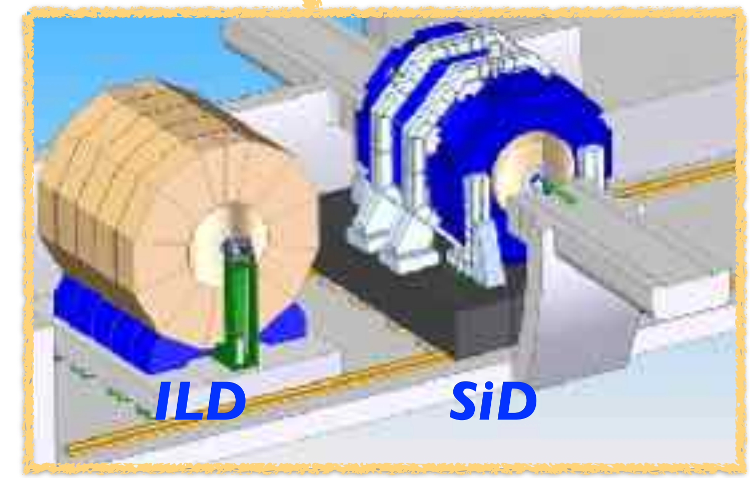
Key Technologies for ILC





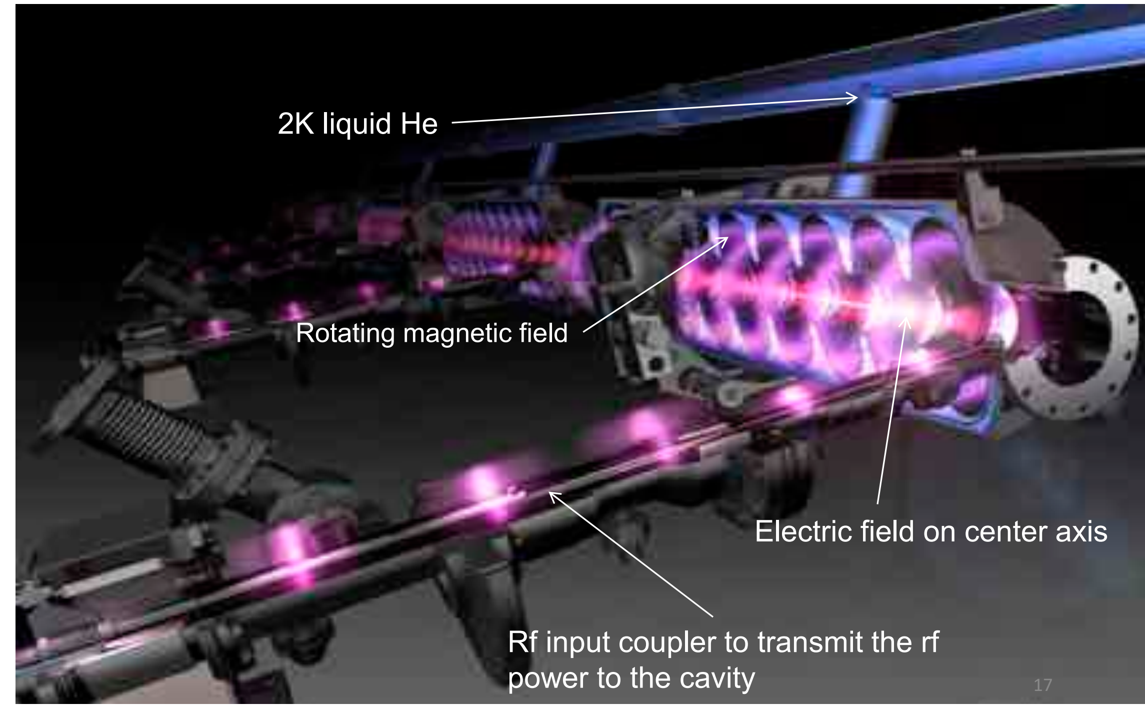
- **Accelerator**
  - Polarised electrons/positrons
  - Low emittance beam at damping ring
  - Main linac based on Superconducting Radio Frequency (SCRF)
  - Nanometer beams at final focusing
- **Detector**
  - High-precision detector based on particle flow calorimetry
  - Two detectors with push-pull operation
- **Technical Design Report (TDR) published in 2013**

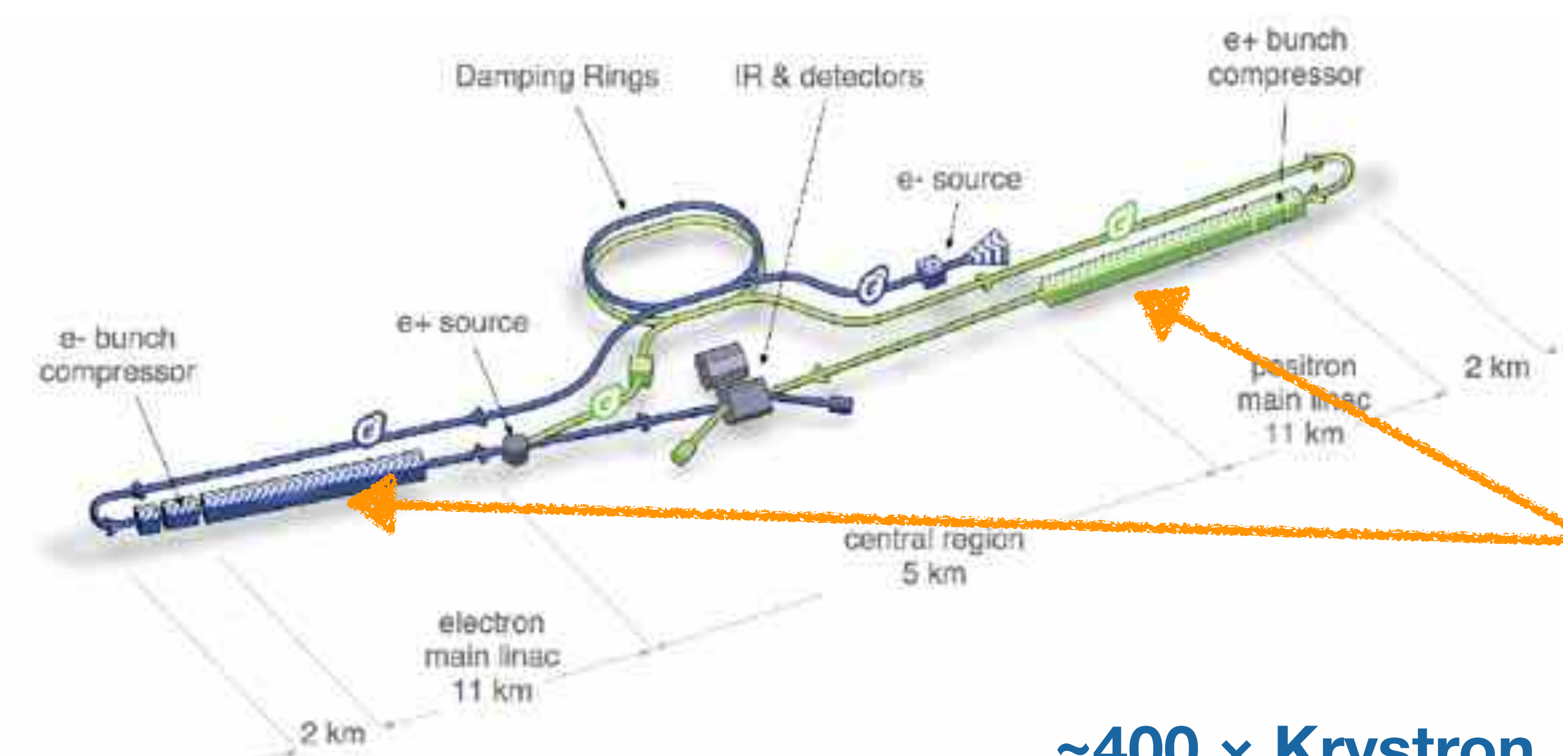
→ILC is technically ready for construction!

Superconducting RF Technologies

- **Main linac**
  - Superconducting RF cavity made of Nb
  - Average field gradient: 31.5MV/m±20%
  - Q_0~10^{10}
  - Yield of cavity production ~90%→ need to produce 17,600 cavities

    →Need industrialisation





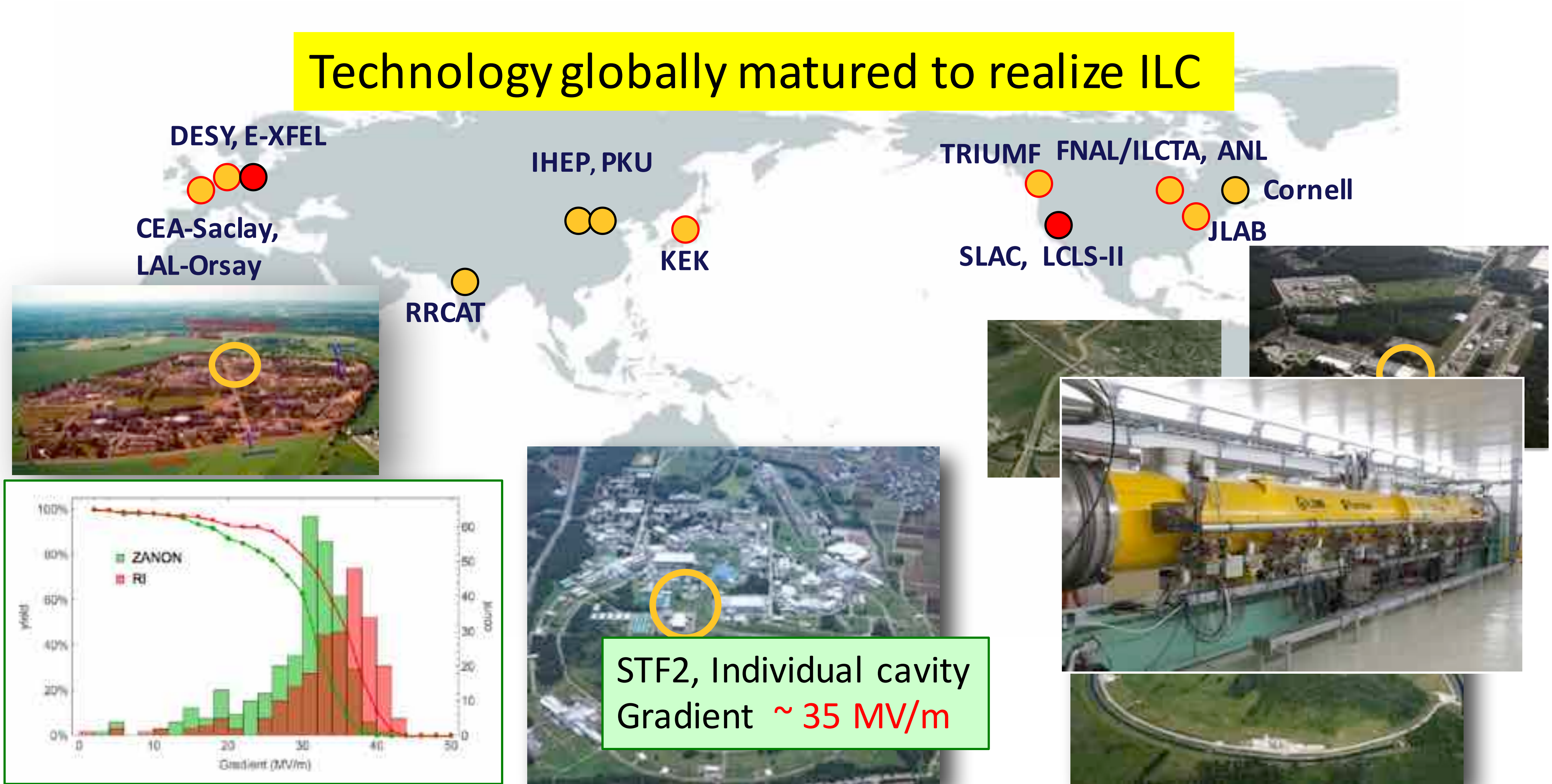
~16,000 × Cavities

~1,800 × Cryo-modules

~400 × Krystron

SRF Cavity

- **Requirements for cavity gradient**
  - >35MV/m for vertical test
  - >31.5MV/m for cryomodule test



*AMTF @DESY/**E-XFEL**, CM*

STF-CFF @ KEK

ASTA @ FNAL, TEDF @ JLab

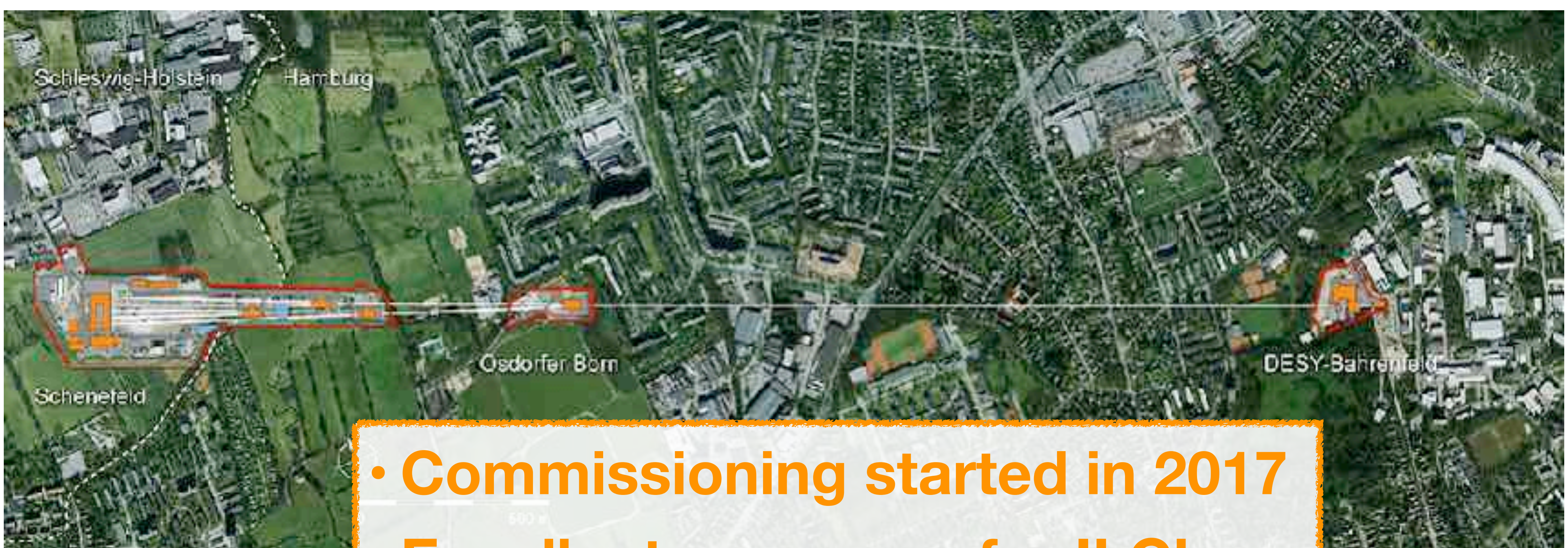
➢ 800 cavities are completed with < 30 MV/m >

Courtesy of K. Kawagoe

Cryomodule test at Fermilab reached < **31.5** > MV/m, exceeding ILC specification

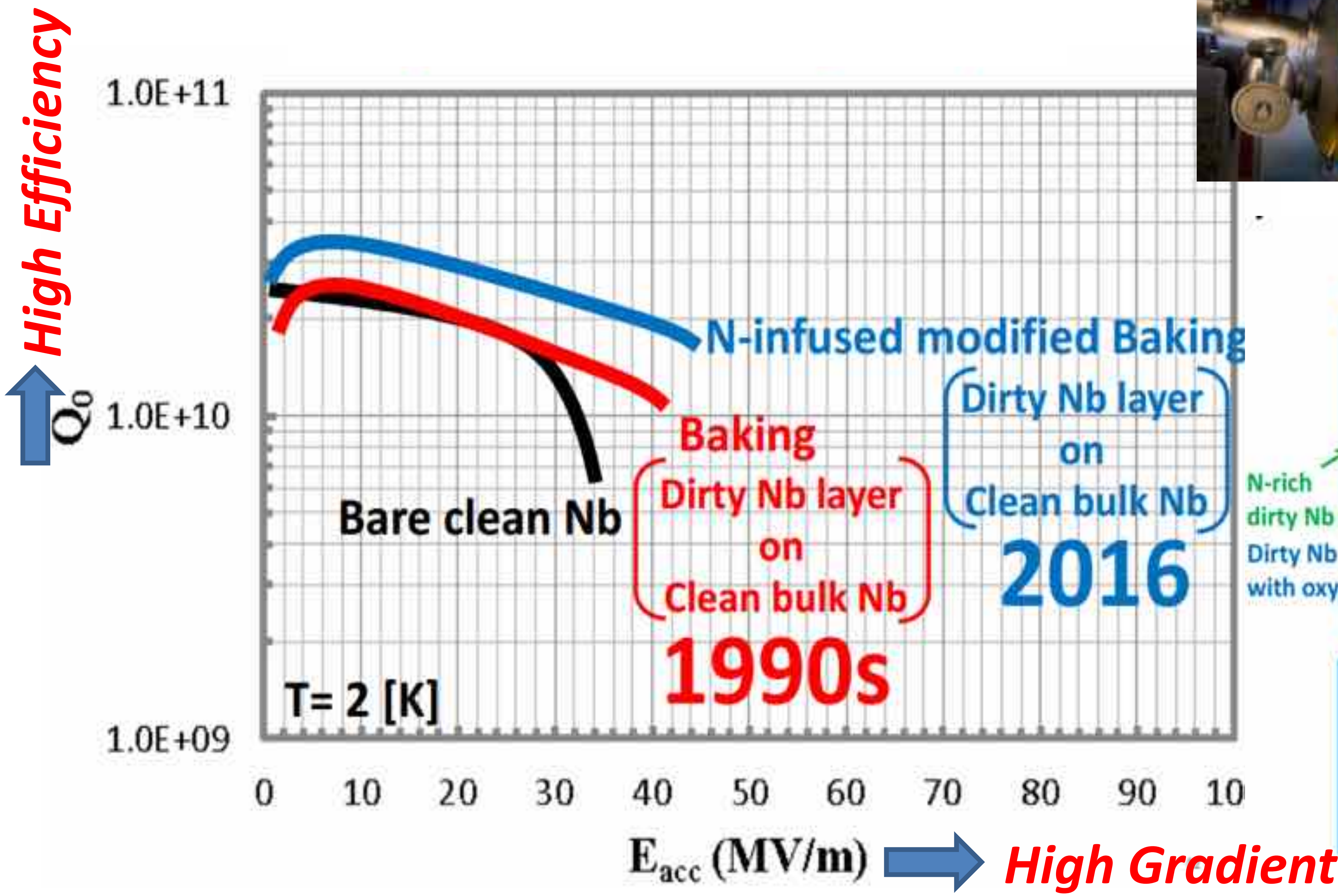
European XFEL

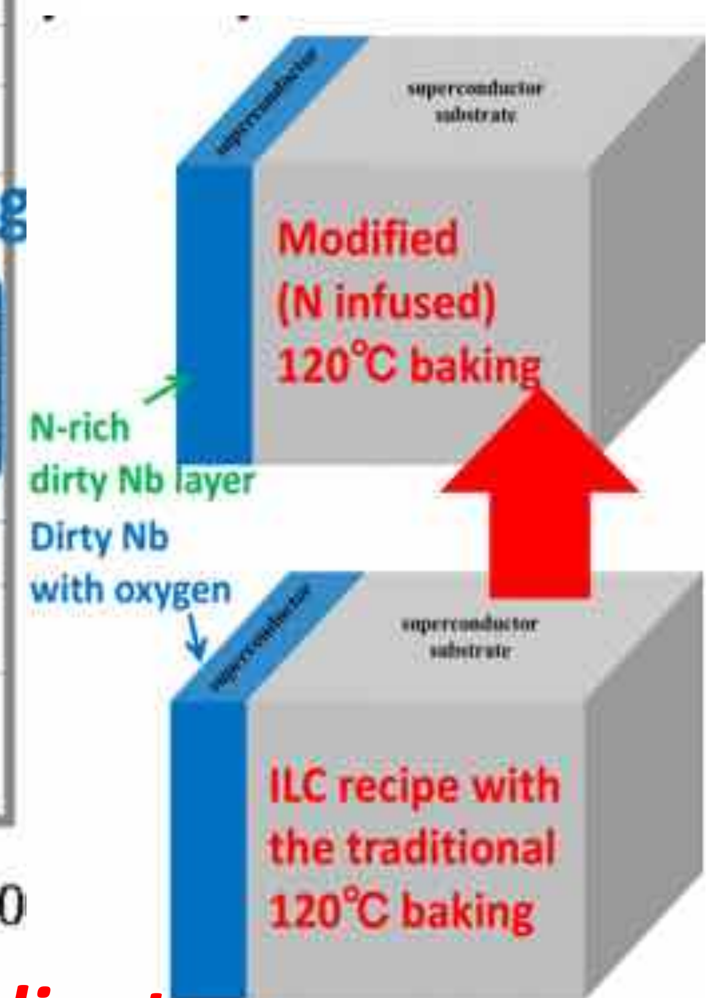
- Same SRF technology as ILC
- ~1km SC Linac with E=17.5GeV
- 23.6MV/m (1.3GHz)
- ×100 cryomodules, ×800 SRF cavities
  - Cavity production by RI and Zanon
  - Assembled and tested at CEA-Sacray and DESY
- ×1/20 scale w.r.t. ILC (500GeV)



- **Commissioning started in 2017**
- **Excellent precursor for ILC!**

Recent Breakthrough for Higher Gradient

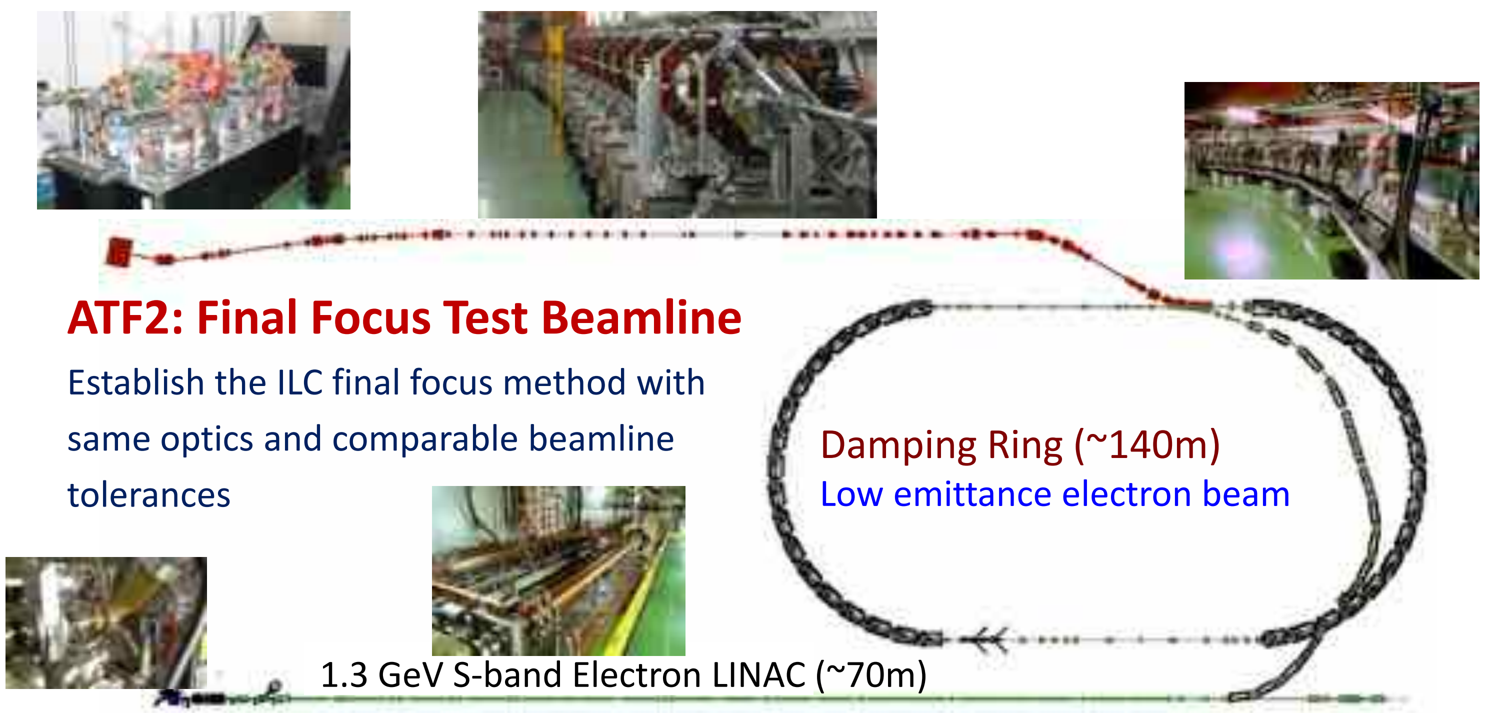


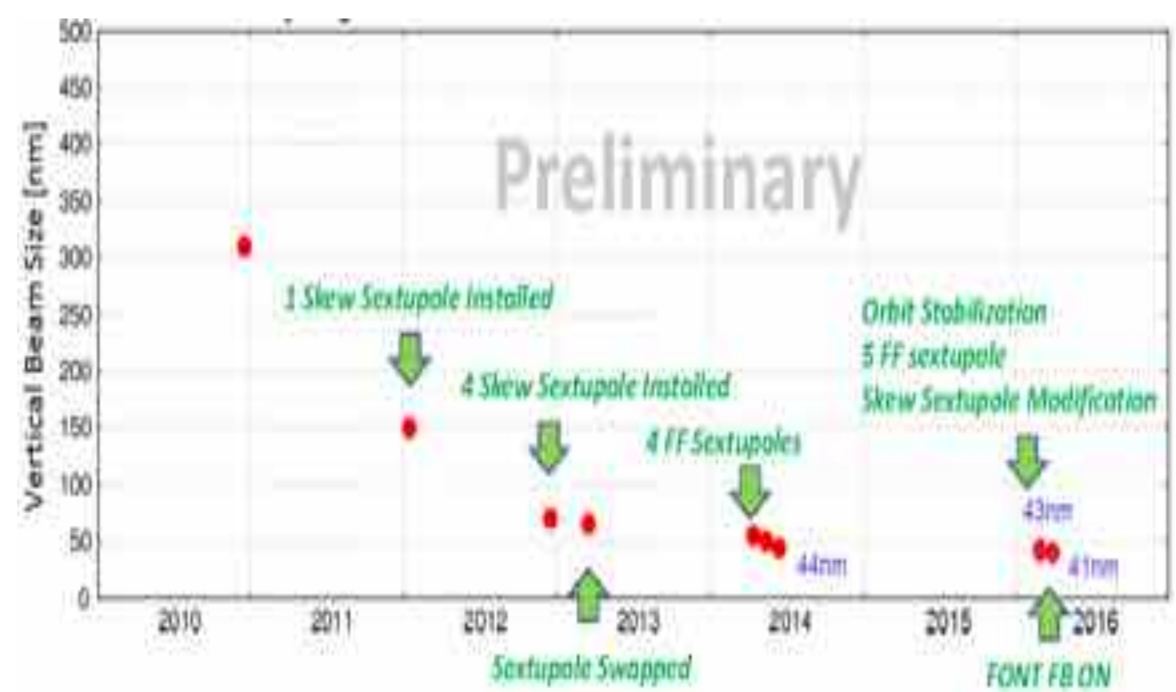


Courtesy of S. Michizono

Nano-beam Technology

- **Vertical beam size at IP**
  - Goal at ILC: 6nm
  - R&D on final beam focusing technologies at KEK-ATF/ATF2
  - Goal at ILC (6nm) ↔ Goal at ATF2 (37nm), considering dependence of beam energy



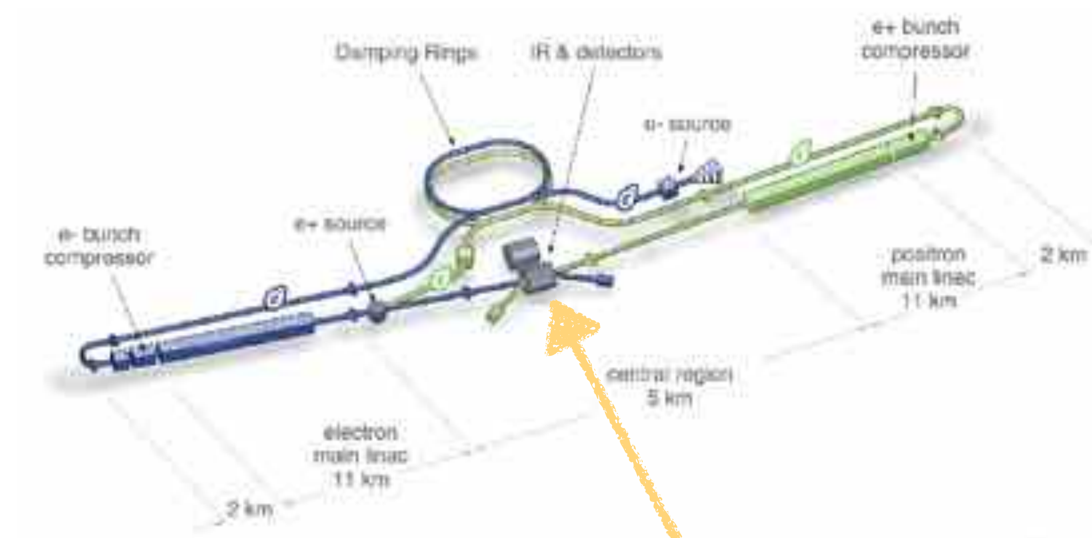


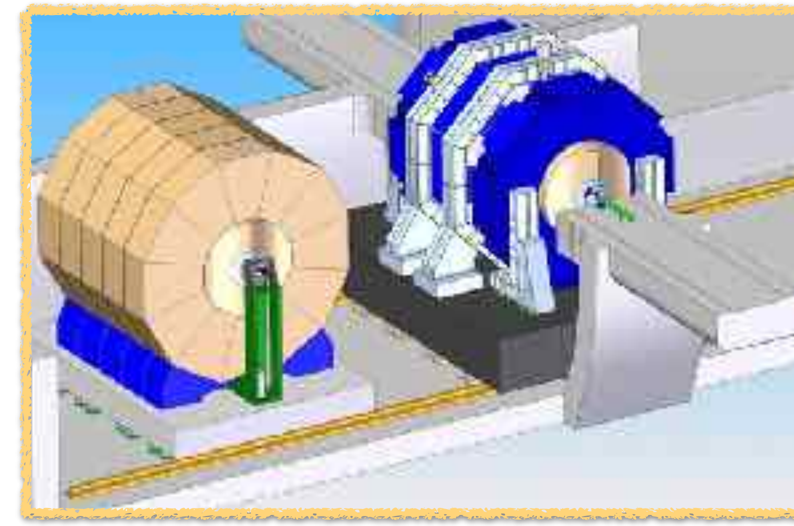
Av. vertical beam size of 41nm achieved (2016)!

N.B. 6nm at ILC (goal) ↔ 37nm at ATF2

ILC Detectors

- **Two detector concepts for ILC**
  - SiD & ILD
  - Both designs optimised for particle flow calorimetry for the best jet energy reconstruction
  - Push-pull operation





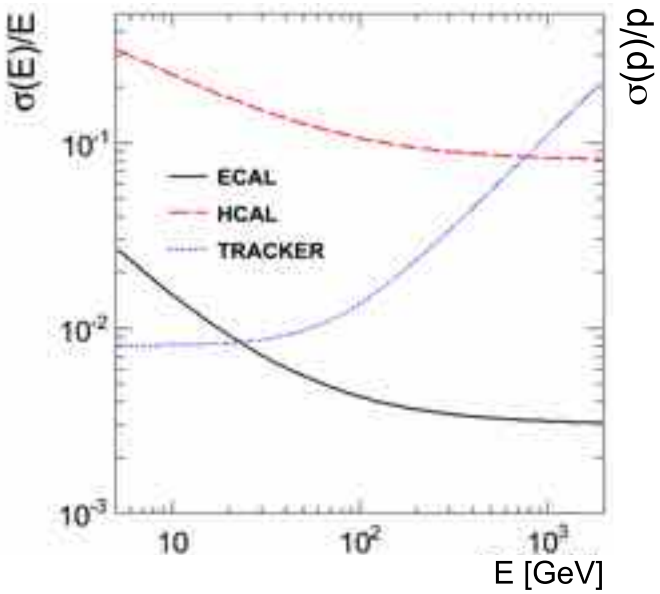
- **Silicon Detector (SiD)**
  - Cost-constrained detector with 5T B-field and silicon tracking
  - Time-stamping on single bunch crossings
  - High granularity calorimeter optimised for particle flow analysis
- **International Large Detector (ILD)**
  - Large detector optimised for good energy and momentum resolution
  - Tracking with Time Projection Chamber (TPC) for excellent pattern recognition an dE/dx capability
  - High granularity calorimeter optimised for particle flow analysis

SiD

ILD

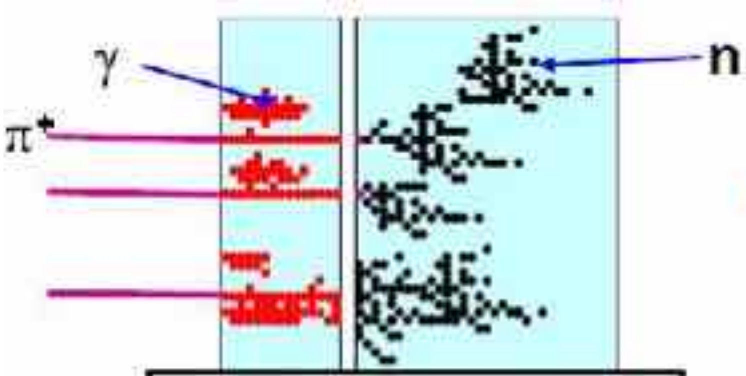
Particle Flow Calorimetry

Performance of subdetectors



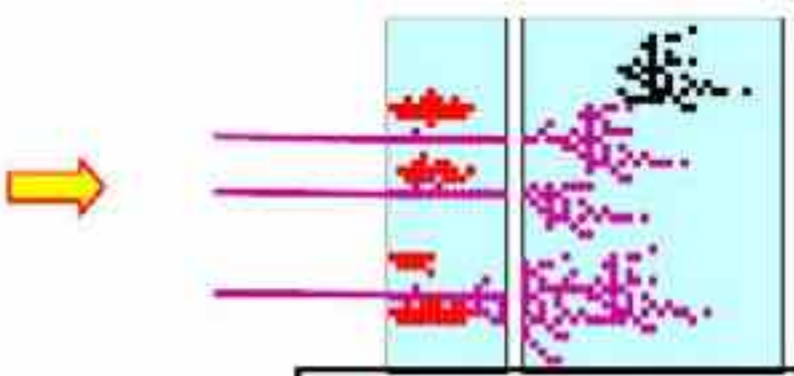
- Typical composition of jet
  - Charged particles (av. energy fraction 64%)
  - Photons (av. energy fraction 25%)
  - Neutral hadrons (av. energy fraction 11%)
- Conventional calorimetry
  - All jet energy measured with ECAL+HCAL
  - ~70% of energy measured in HCAL where energy resolution is intrinsically limited
- Particle flow calorimetry
  - Measurements with best suited detectors depending on particle type!
  - Charged particles → tracker
  - Photon → ECAL
  - Neutral hadrons → HCAL

Conventional calorimetry



$E_{JET} = E_{ECAL} + E_{HCAL}$

Particle flow calorimetry



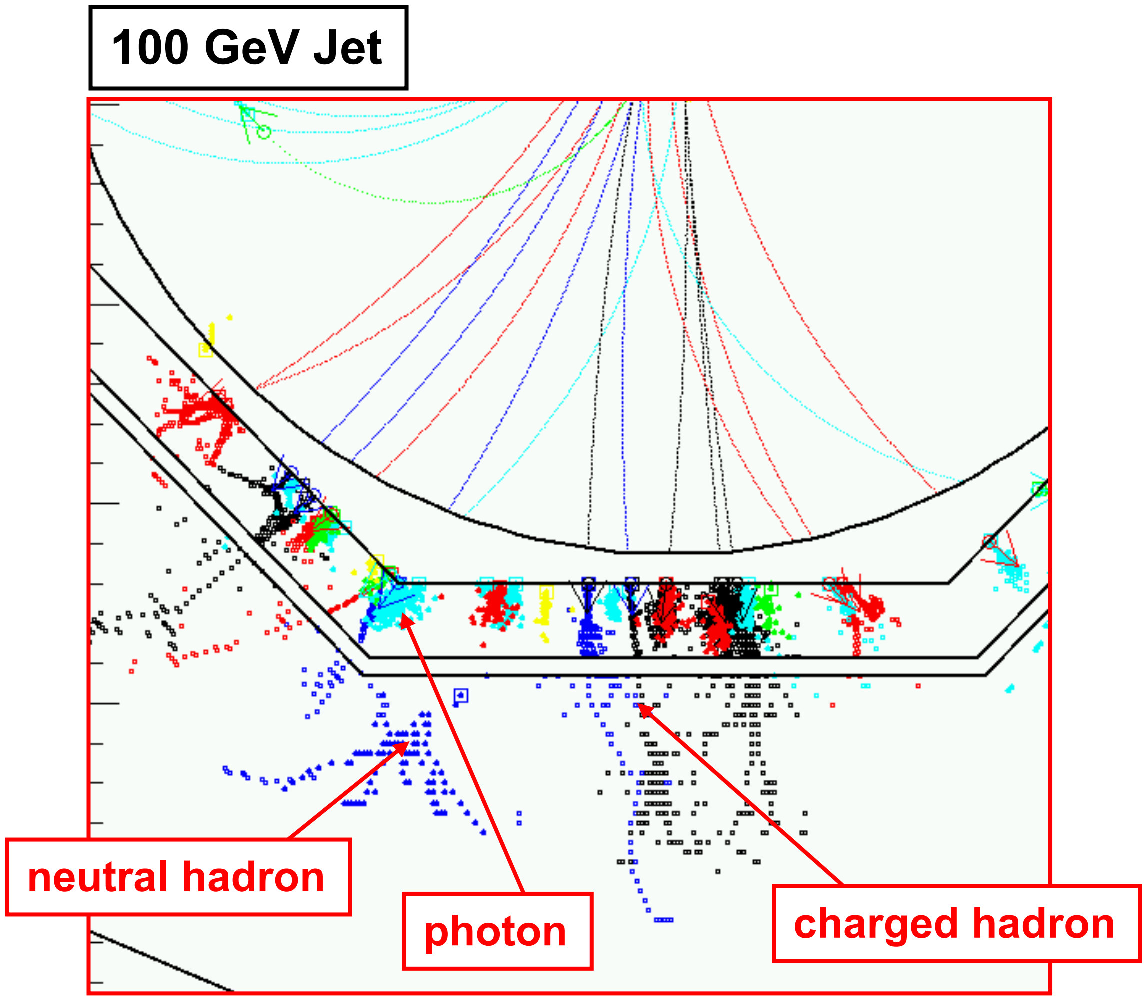
$E_{JET} = E_{TRACK} + E_{\gamma} + E_{n}$

Particle Flow Calorimetry

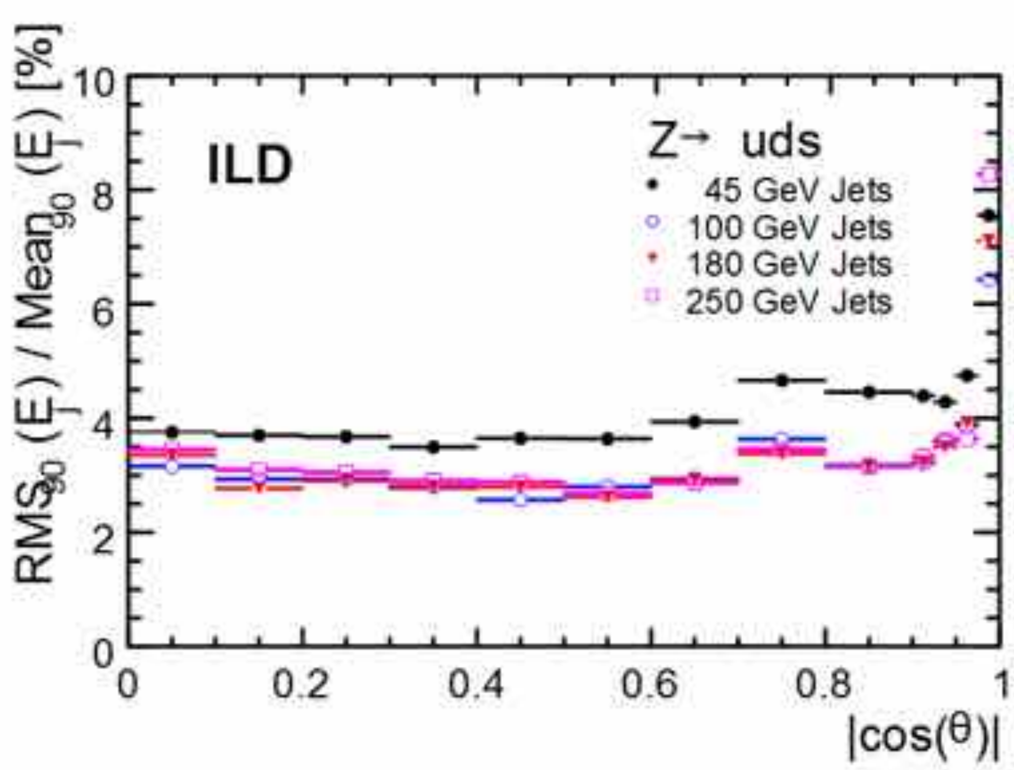
- **Reconstruction of four-vectors of all visible particles in a jet requires**
  - Highly granular calorimeters
  - High precision tracker

# of ch	ECAL	HCAL
ILD	100M	10M
LHC	76k(CMS)	10k(ATLAS)

Particle flow reconstruction



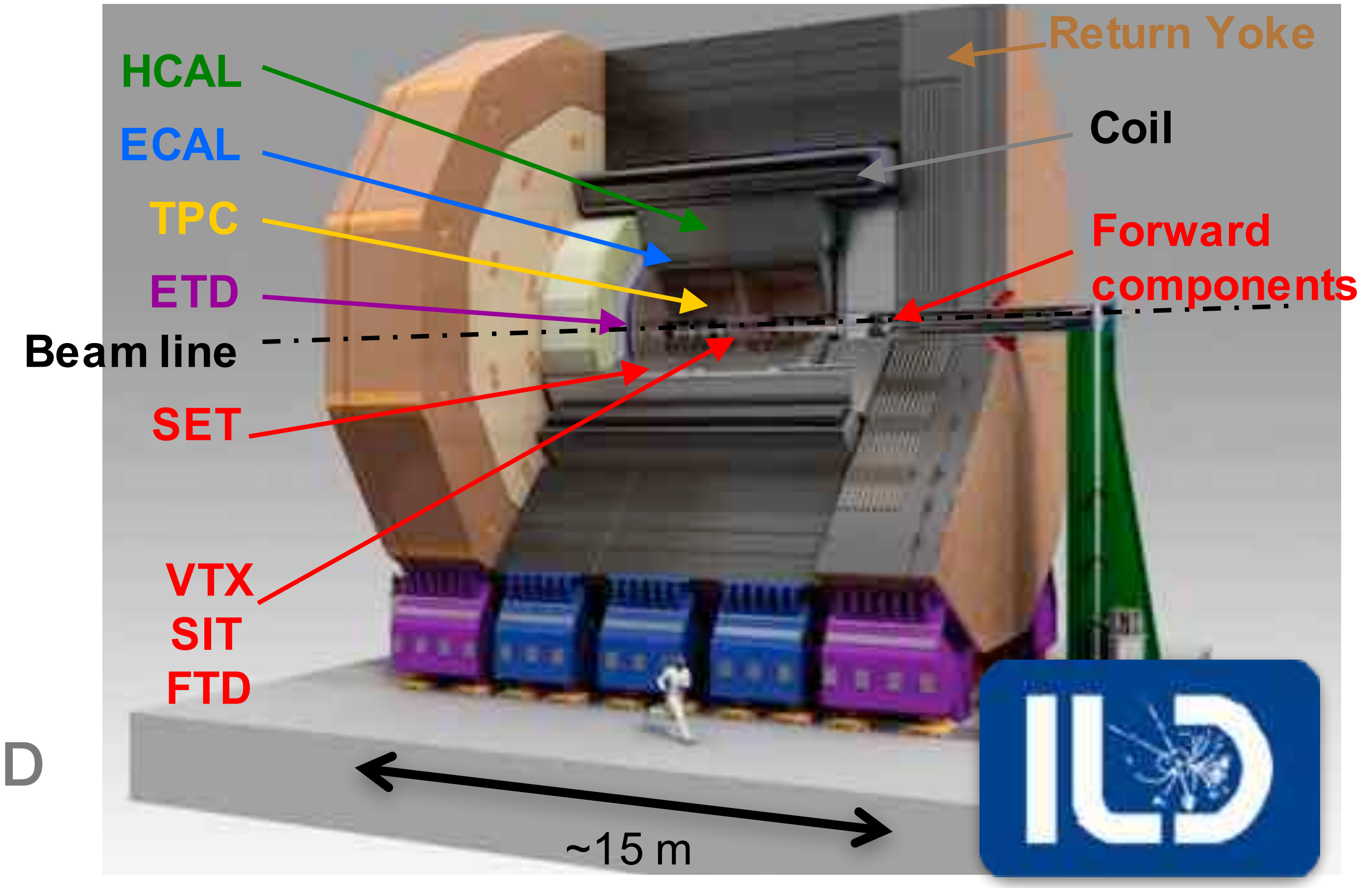
Expected Jet energy resolution



3-4% jet energy resolutions!

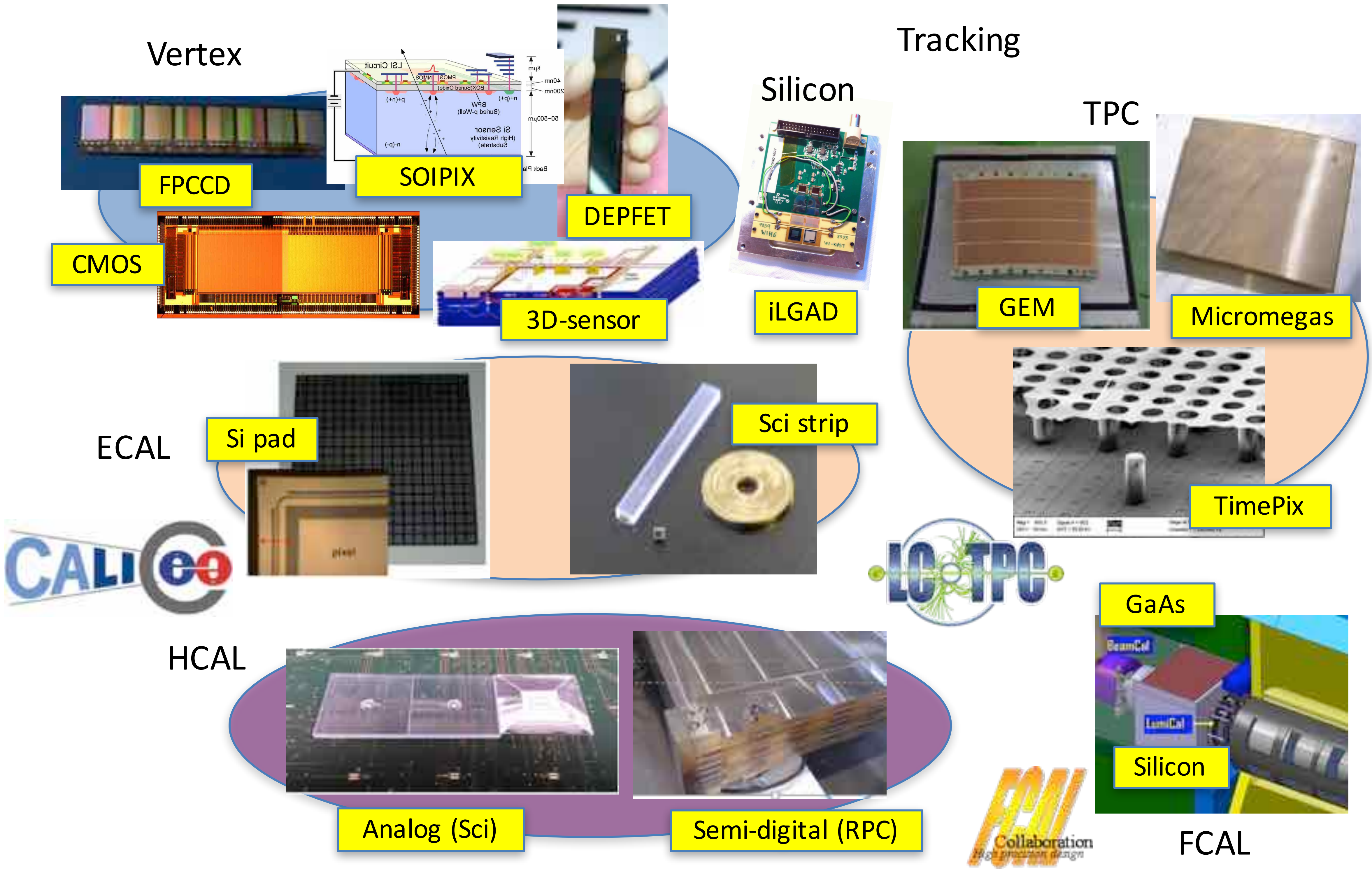
Particle Flow Detector ILD

- **Vertex detector**
  - Silicon pixel
  - $\sigma_{IP}=5\mu m \oplus 10\mu m/p\sin^{3/2}\theta$
- **Tracking**
  - Inner and outer silicon layers
  - TPC central tracker
  - High resolution, low mass, dE/dx particle ID
  - $\sigma(1/p_T)=2\times10^{-5}$ GeV^{-1}
- **Calorimeters**
  - High granularity for particle flow calorimetry (ECAL:0.5cm, 10^8 cells, HCAL:1-3cm, 10^7-10^8cells)
  - Unprecedented jet energy resolution: 3-4% multi-jet events at 500GeV
  - Both design optimised for particle flow calorimetry



Sub-detector Technologies

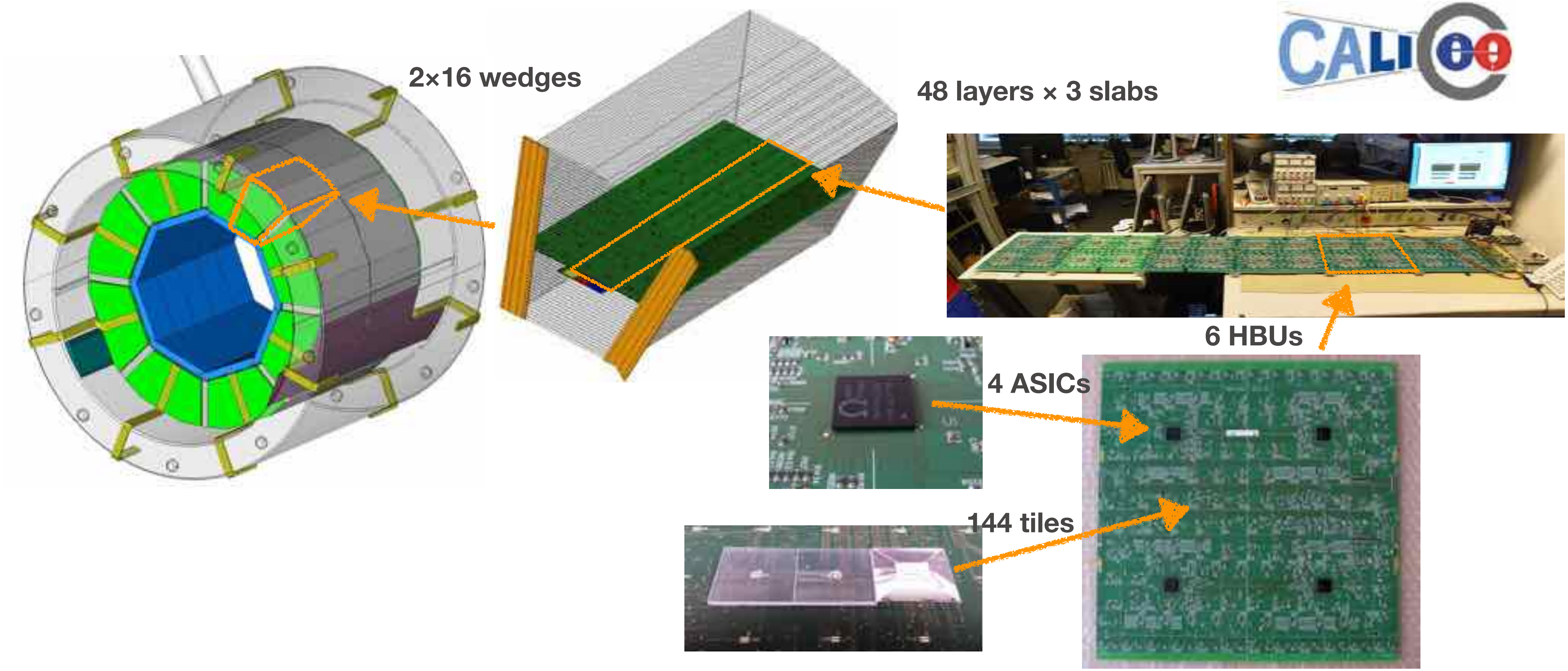
- Various technology options under study by international collaborations



Just shows part of R&D activities

High Granularity Hadronic Calorimeters

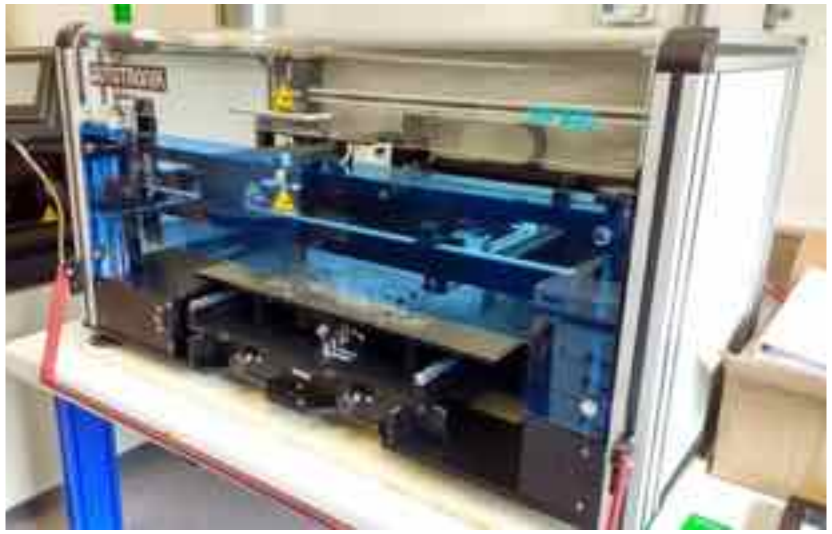
- **Analogue Hadron CALorimeter (AHCAL)**
  - 8×10^6 square scintillator tiles ($30\times30\times3mm^3$ each) readout by SiPM ($\sim1.3\times1.3mm^2$)
  - 48 layers (scintillator active layer + steel/tungsten absorber layer)
  - Fully integrated readout electronics
- **Excellent performance demonstrated in physics prototype**
- **Now working with technological prototypes**
  - Demonstrated scalability to full detector layout



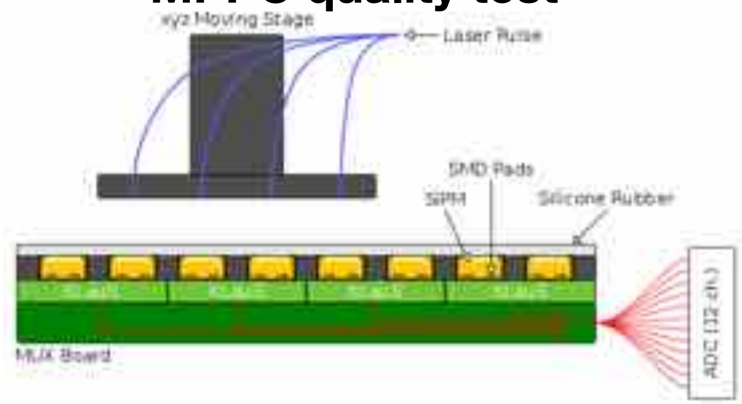
AHCAL Large Prototype

- **A full hadronic prototype under construction**
  - 48 layers (scintillator active layer + steel/tungsten absorber layer)
  - ~23k tiles
  - Fully integrated readout electronics
  - Demonstrate scalability to full detector layout

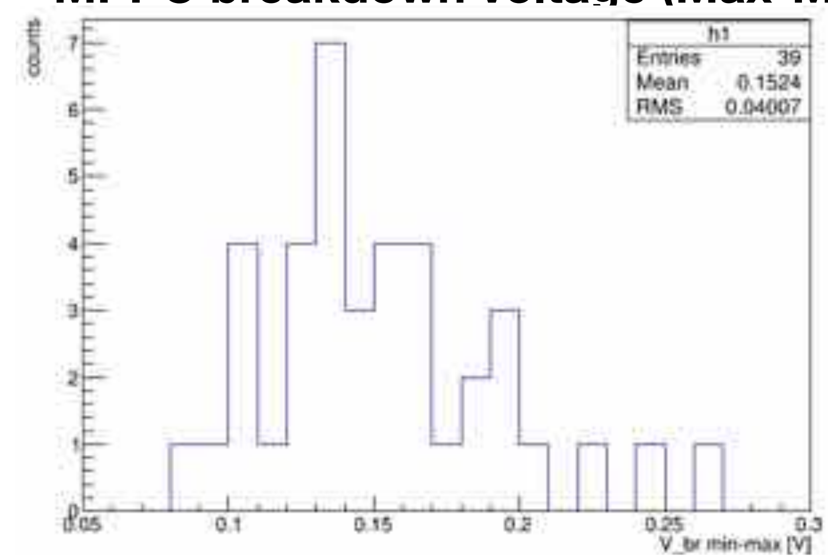
New pick-and-place machine and screen printer (glueing) installed (Mainz)



MPPC quality test



MPPC breakdown voltage (Max-Min)



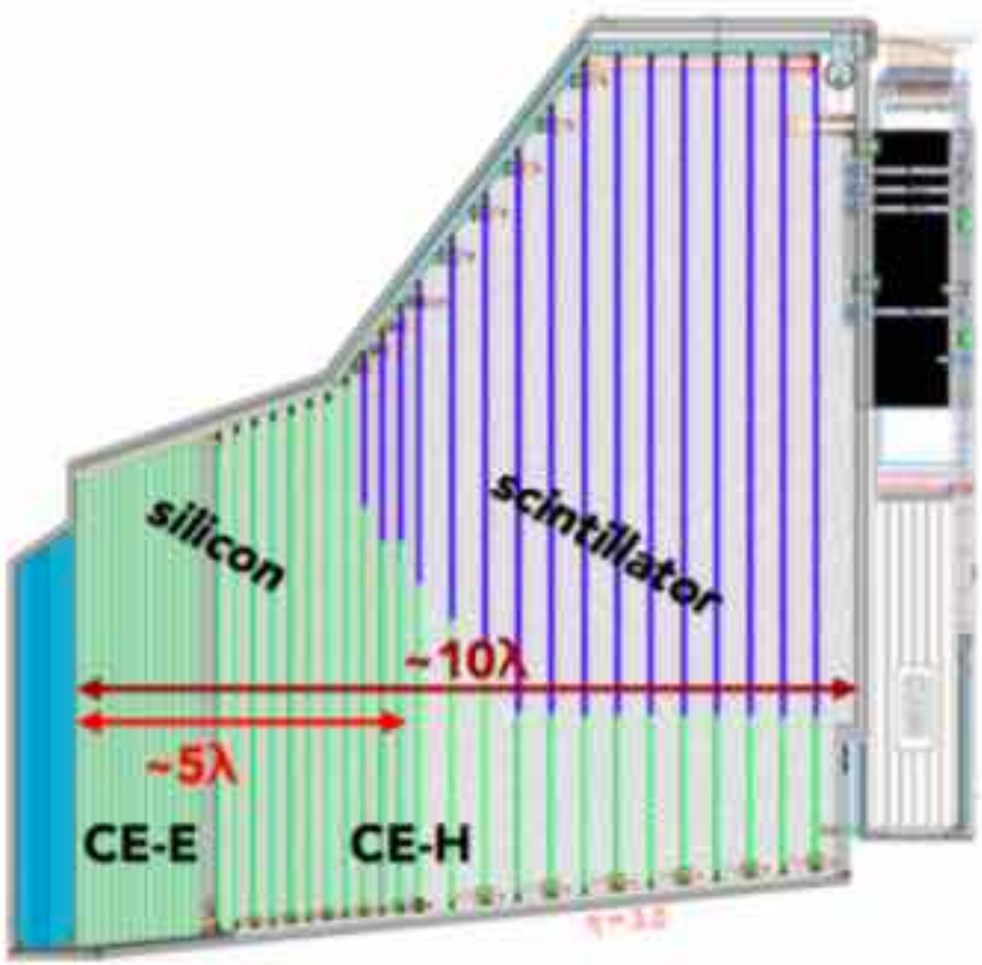
Scintillator tiles (injection molding)

Automatic wrapping machine

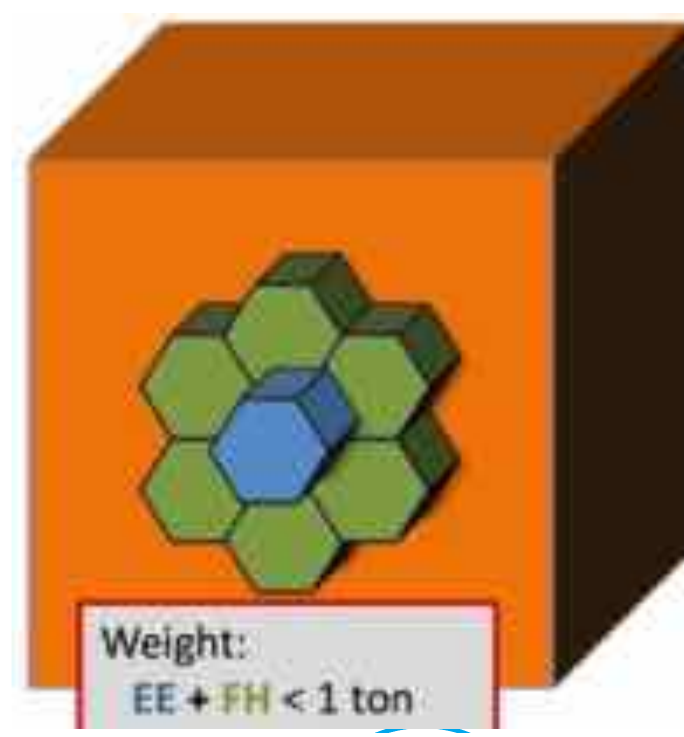
Applications of ILC Detector Technologies

- **CMS HGCAL for HL-LHC**
  - Complete replacement of CMS endcap calorimeters based on ILC calorimeter technology developed by CALICE collaboration
    - Silicon-based calorimeter at ECAL and front HCAL
    - Scintillator-SiPM based calorimeter at rear HCAL
      - Combined test beam experiment with CMS HGCAL and AHCAL (1week in July 2017 at CERN SPS)

CMS HGCAL



HGCAL Prototype



AHCAL small prototype

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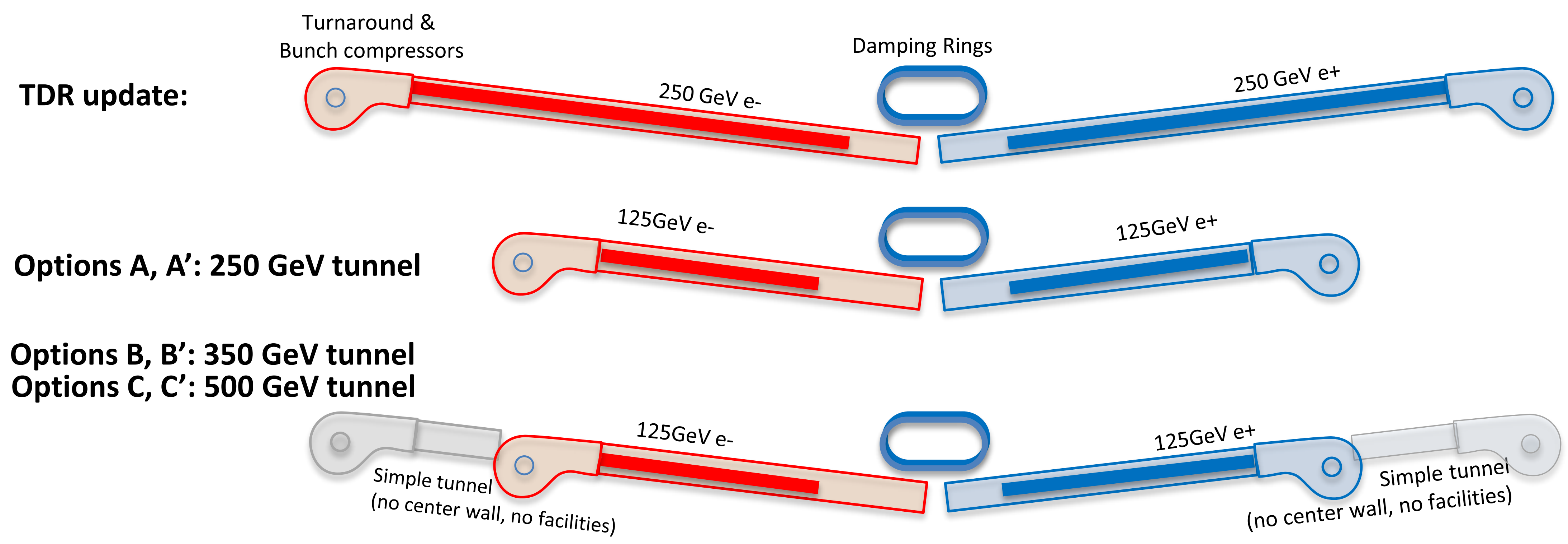
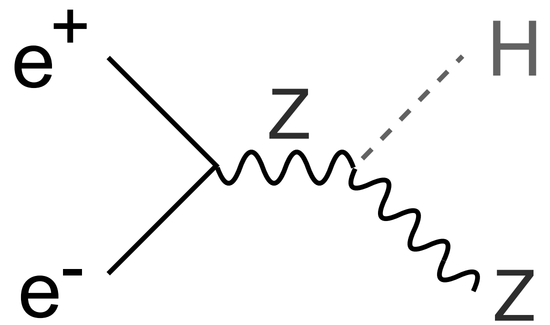
Staged Execution of ILC Project

- Starting at 250GeV as a "Higgs factory" with a luminosity goal of 2ab^{-1} (**"ILC250"**)
- Significant reduction for initial cost by up to 40% compared to 500GeV ILC (TDR)
- Proposed by Japanese HEP community
- Re-evaluation of physics case of ILC at 250GeV by LCC (arXiv:1710.07621) and Japanese HEP community (arXiv:1710.08639)



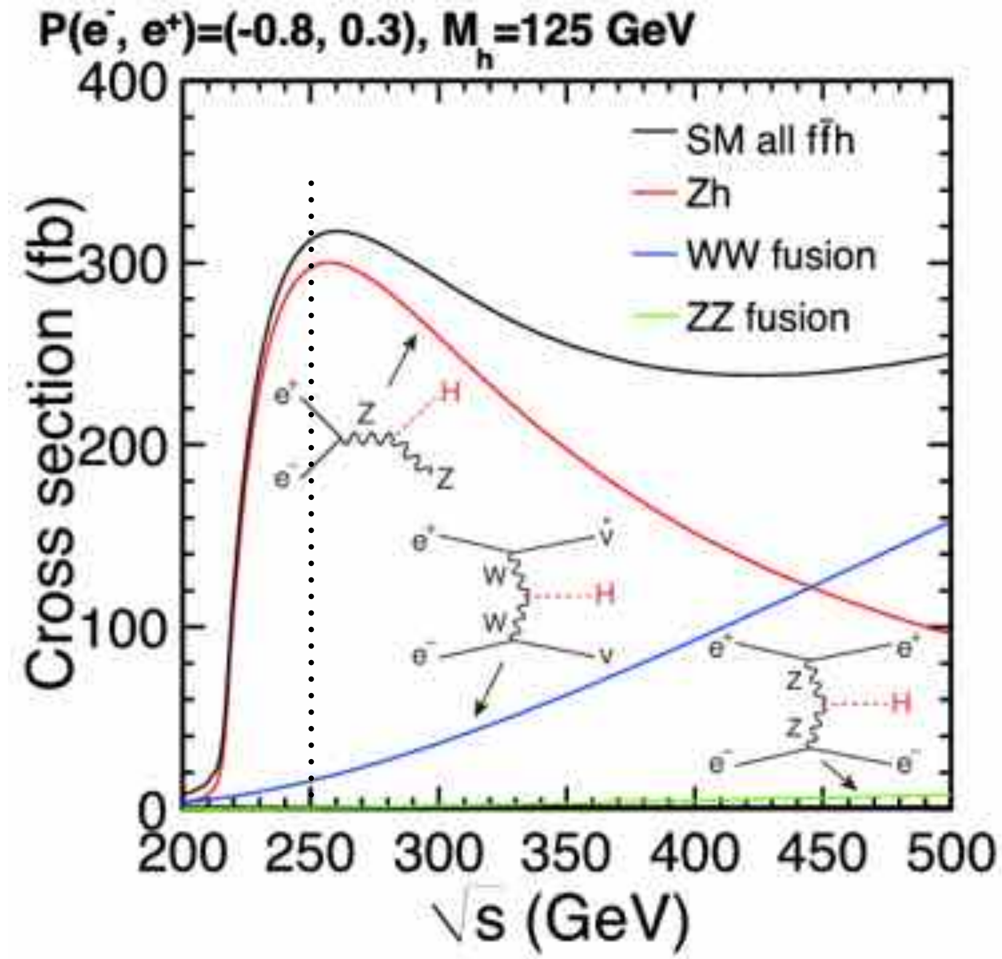
ILC250 should be justified by its own physics case!

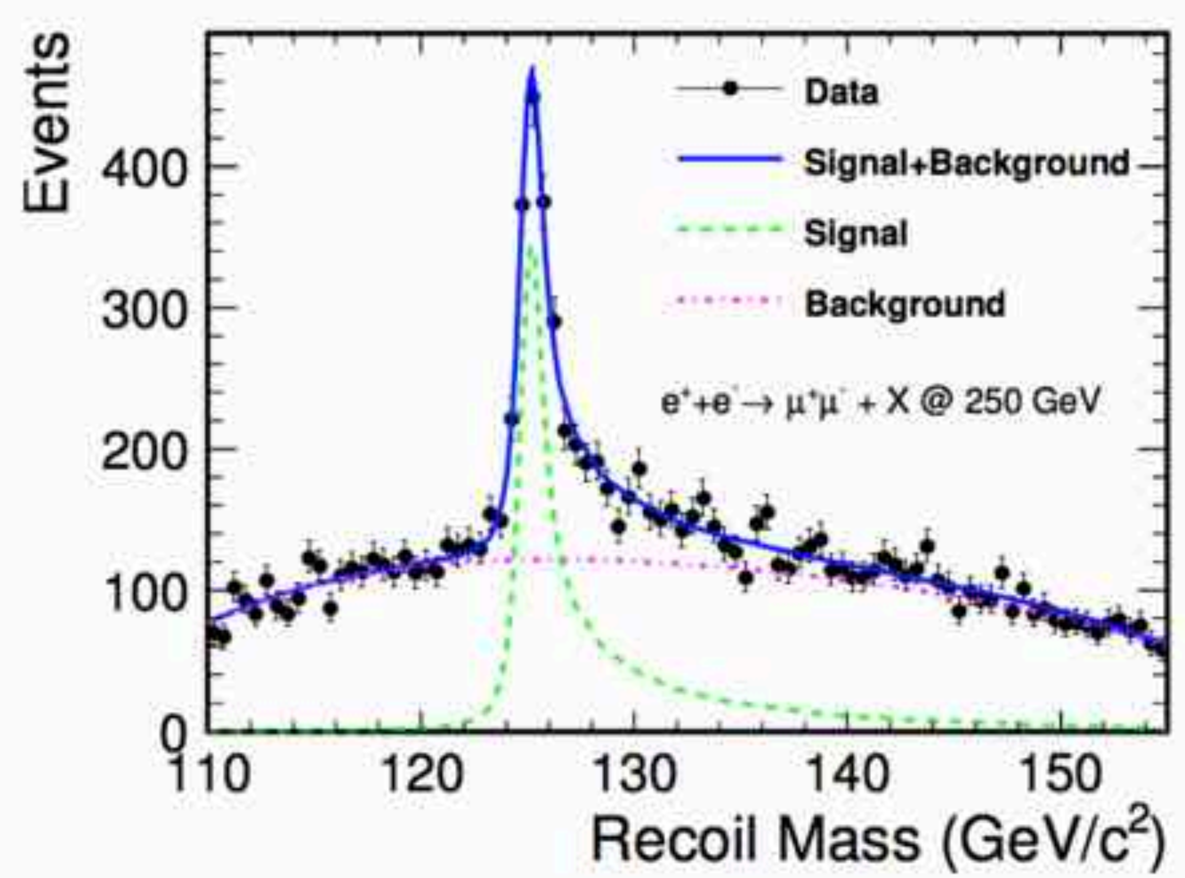
Higgs Physics at 250GeV



- **Higgs production at 250GeV dominated by $e^+e^- \to Zh$**
    - Large and good Higgs sample (~6×10^5 Zh events with $2ab^{-1}$) **"Higgs factory"**
- **Recoil mass method with $e^+e^- \to Zh$**
    - Any Z-boson with E=110GeV selects recoil Higgs regardless of its decay mode (even for invisible decay!)
    - Total cross section can be measured

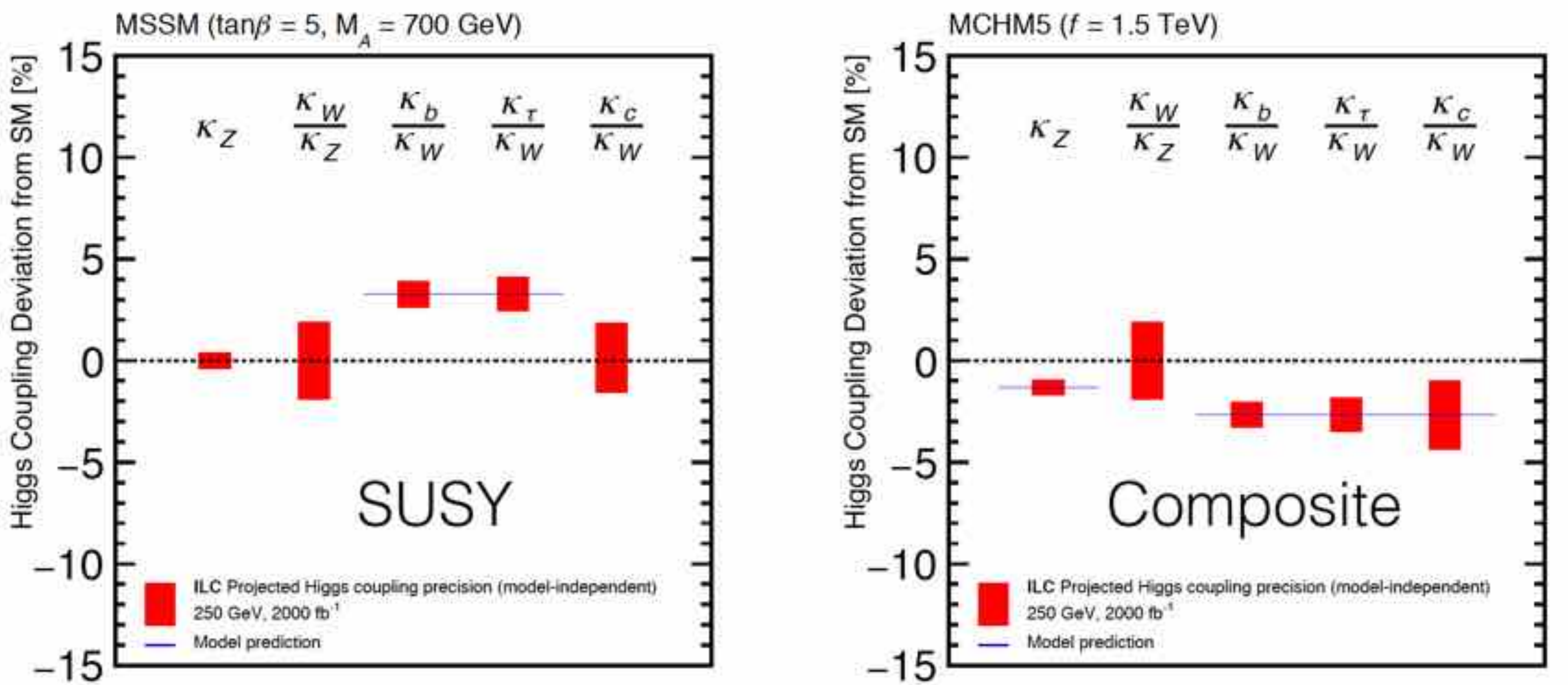
      → Determination of absolute Higgs couplings in a model independent way
    - Higgs invisible decay
    - Higgs mass (δm_h=14MeV↔250MeV@LHC)





Higgs Couplings

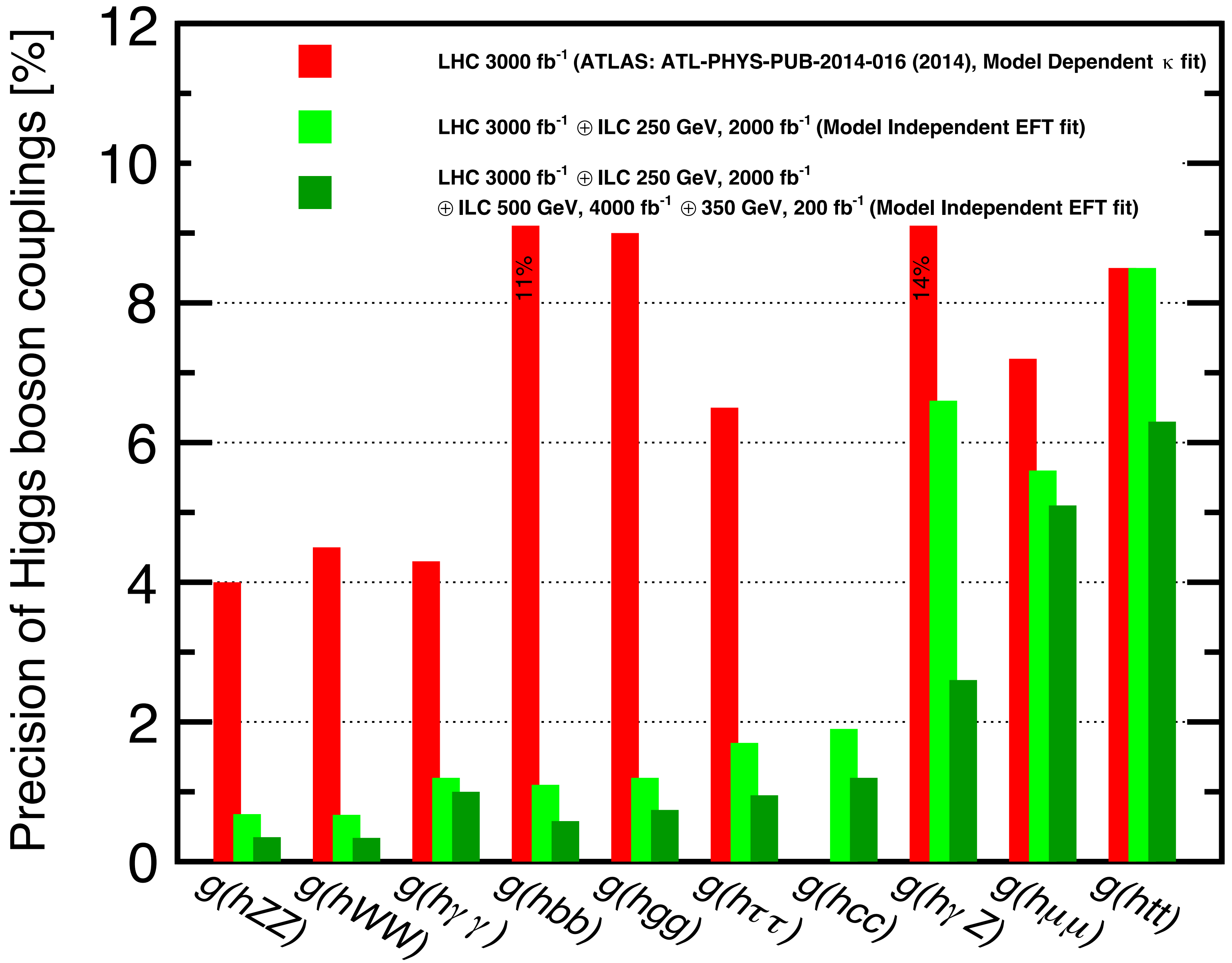
- **Different pattern of Higgs couplings for different BSM model**
  - Distinguish BSM models from observed pattern
- **Need precision <1% for Higgs coupling measurements**



Courtesy of J. Tian

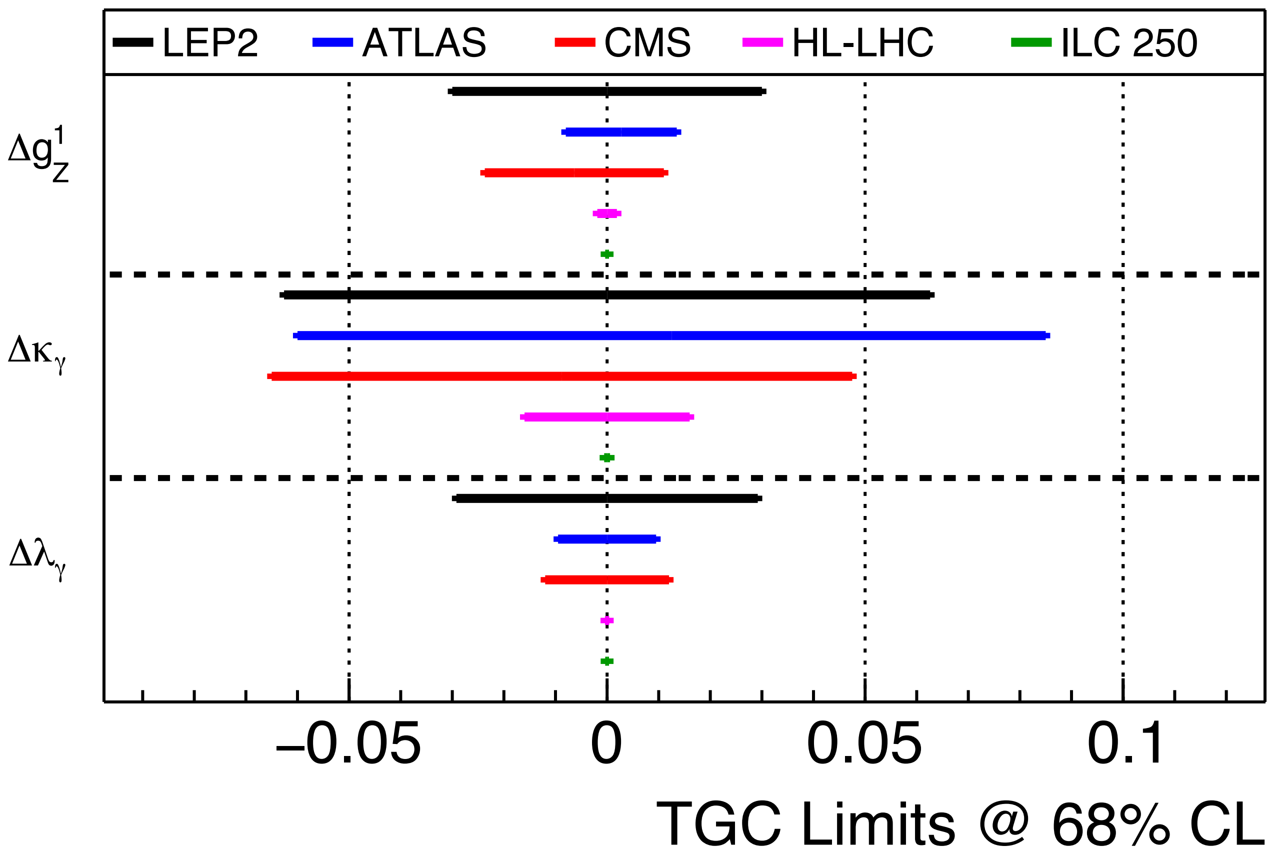
Higgs Couplings

- 1% or better precision is achievable at 250GeV for many couplings
- A factor of two improvement with energy upgrade to 500GeV

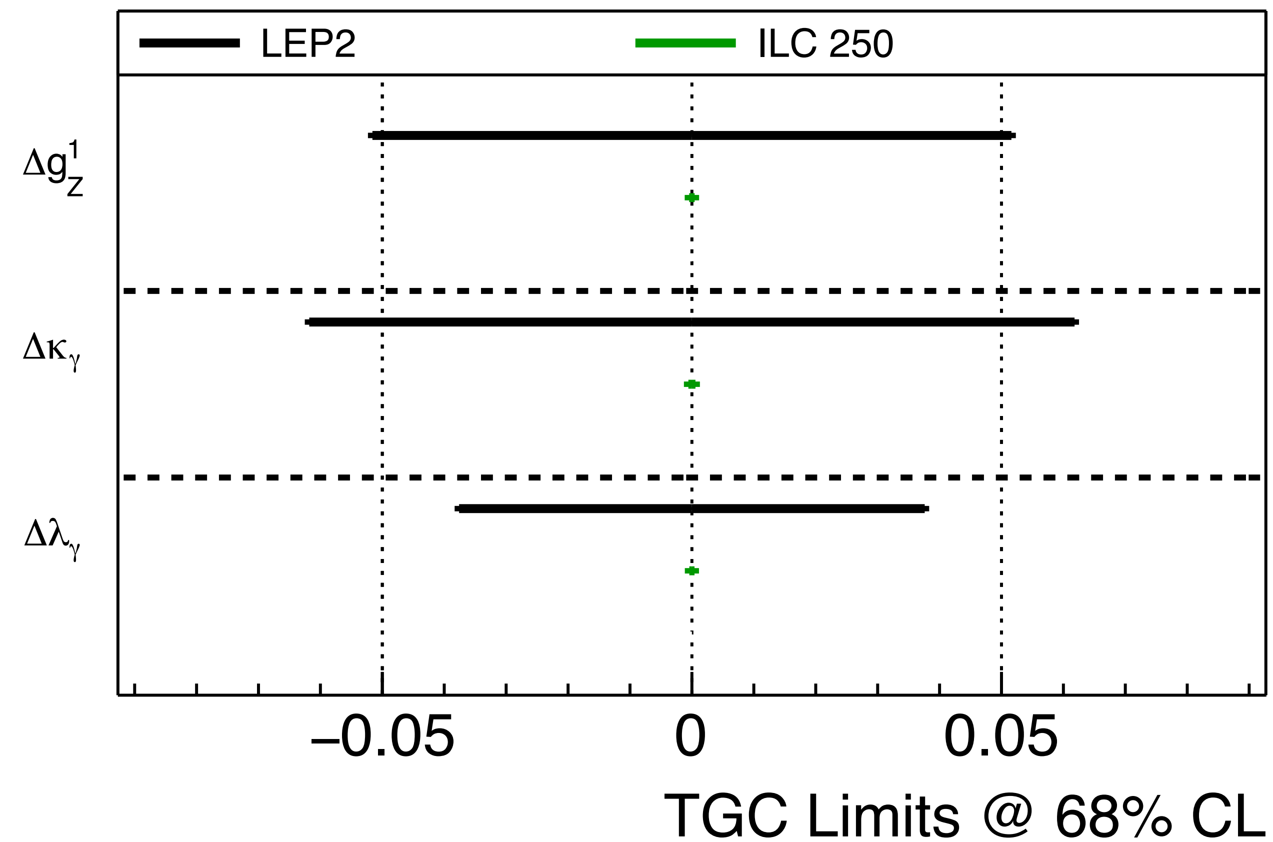


Triple Gauge Couplings

- **Tripe gauge couplings (TGCs), γW^+W^- and ZW^+W^-, can be precisely measured at ILC in $e^+e^- \rightarrow W^+W^-$**
  - A precision of ~10^{-4} expected at ILC250
  - New physics can induce anomalous TGC



fitting individual parameters



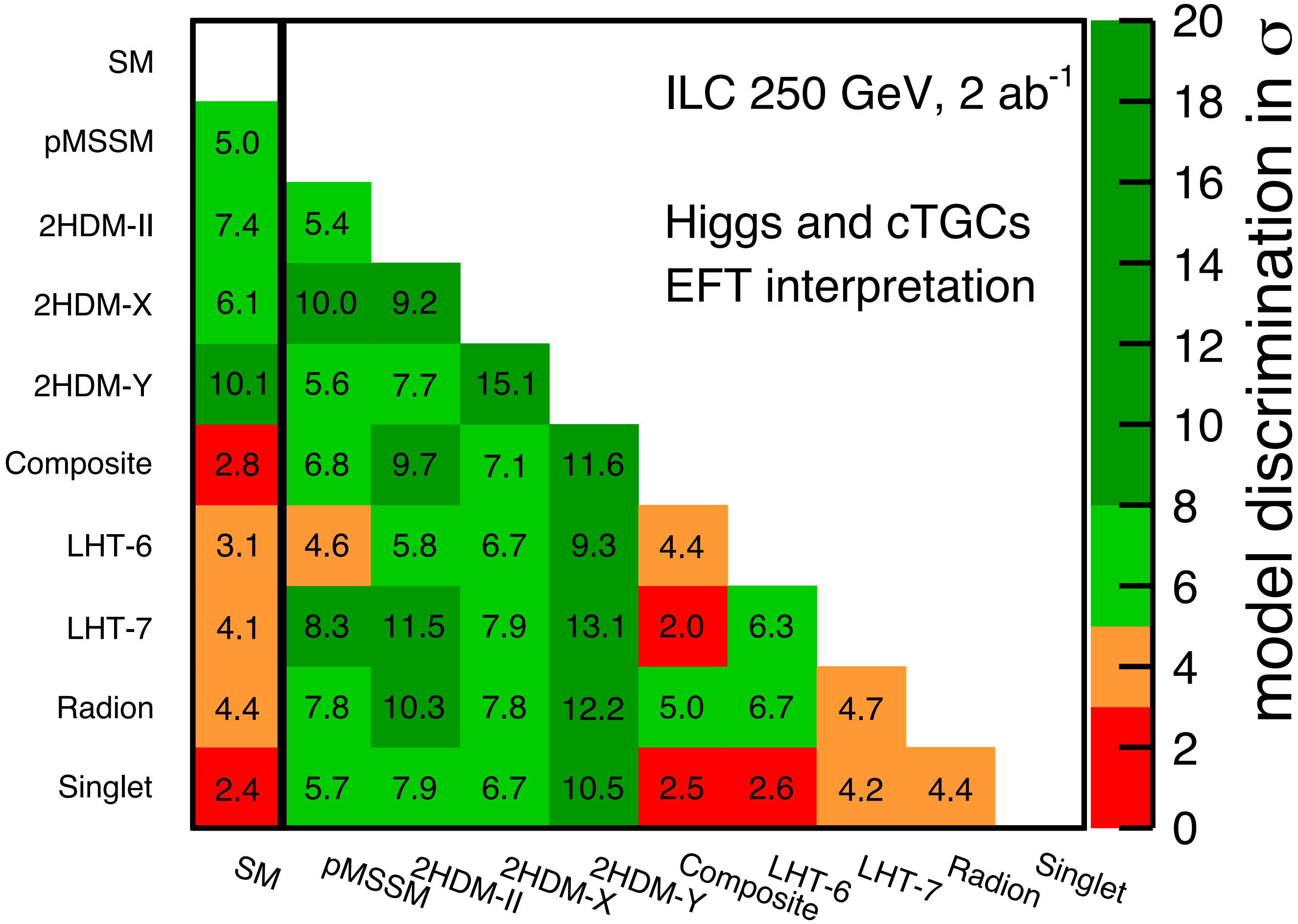
Simultaneous fitting

Discovery Potential for New Physics

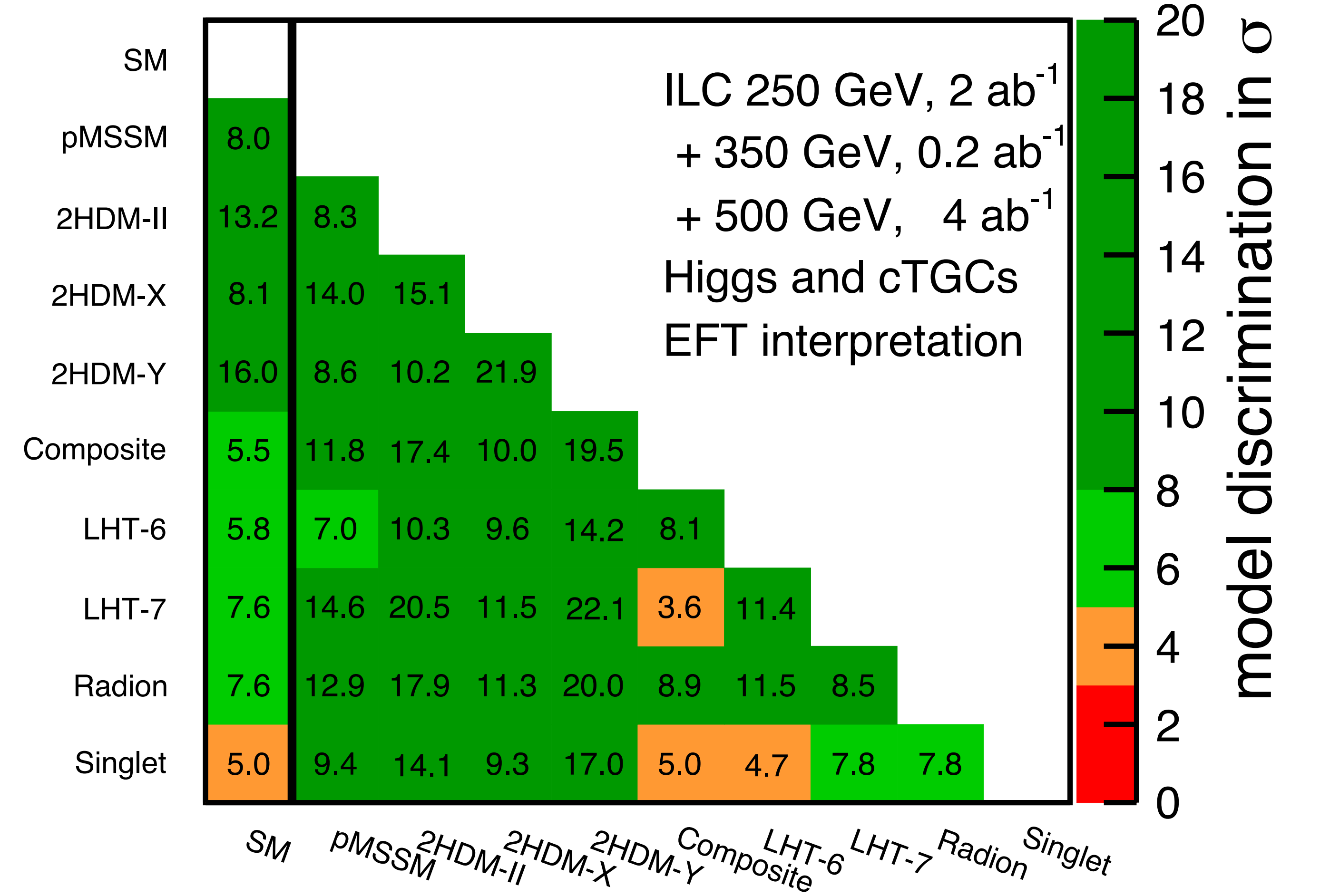
- **Discovery and discrimination sensitivity for BSM models**

  (N.B. BSM models unreachable by HL-LHC chosen)

ILC250

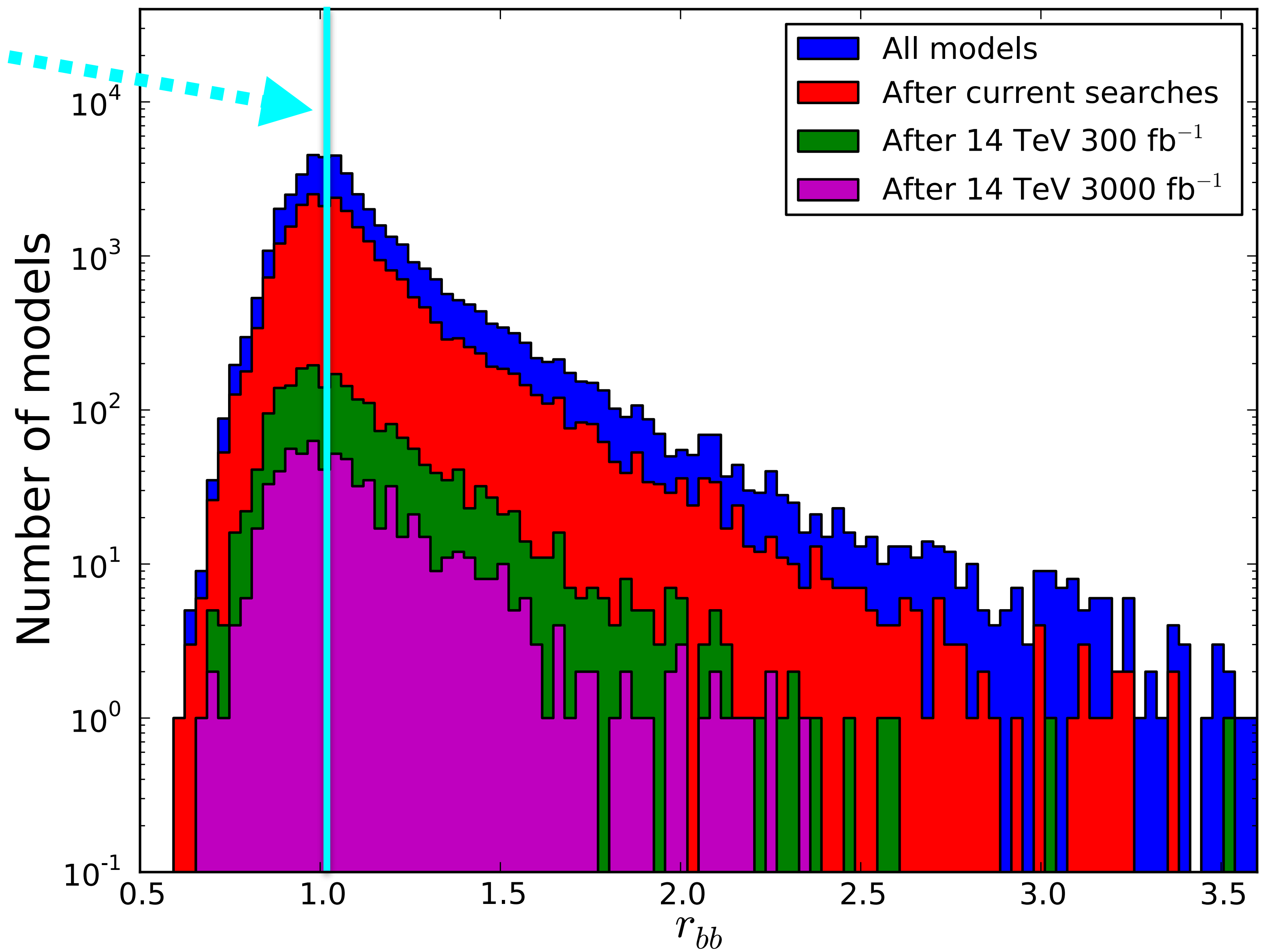


Full ILC program



pMSSM Scan

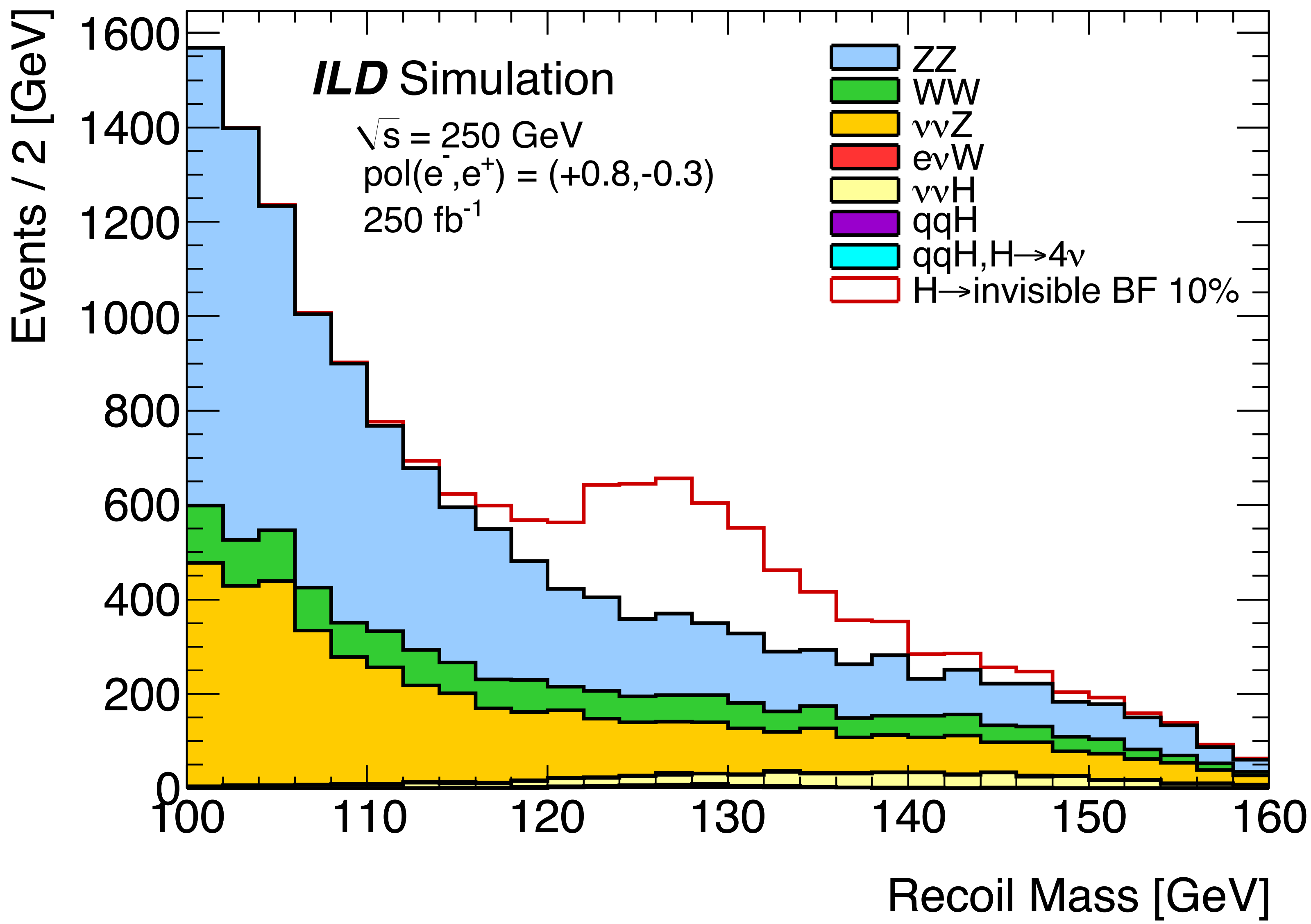
- **Scan over 250,000 points for pMSSM**
  - Phys. Rev. D 90(2014)095017
- **δr_{bb}=1.7% at ILC250**



$$r_X = \frac{\Gamma(h \to X)}{SM}$$

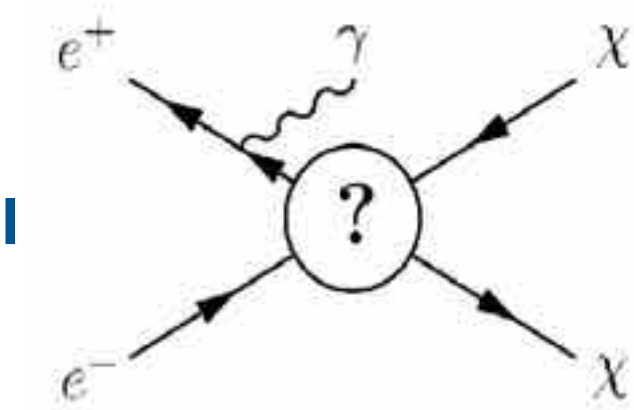
Dark Matter WIMPs

- **Higgs invisible decay to WIMP pair**
  - $m_{WIMP} < 0.5 m_H$
  - Branching ratio sensitivity ~0.3%



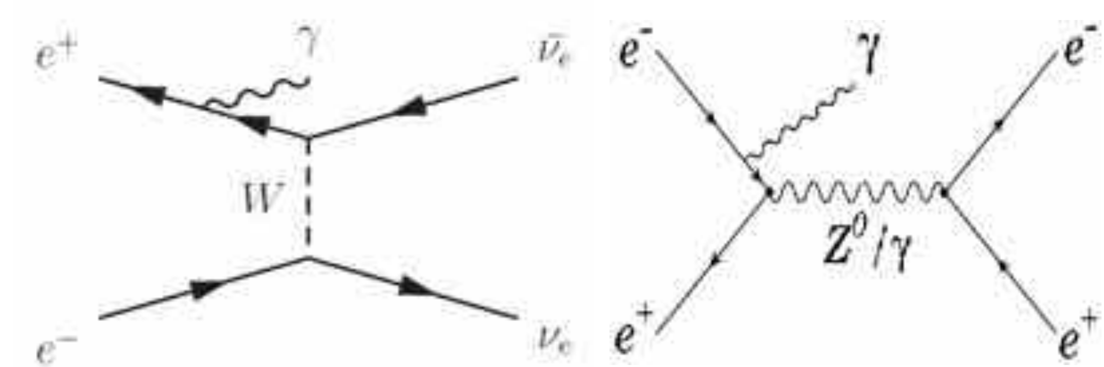
Dark Matter WIMPs

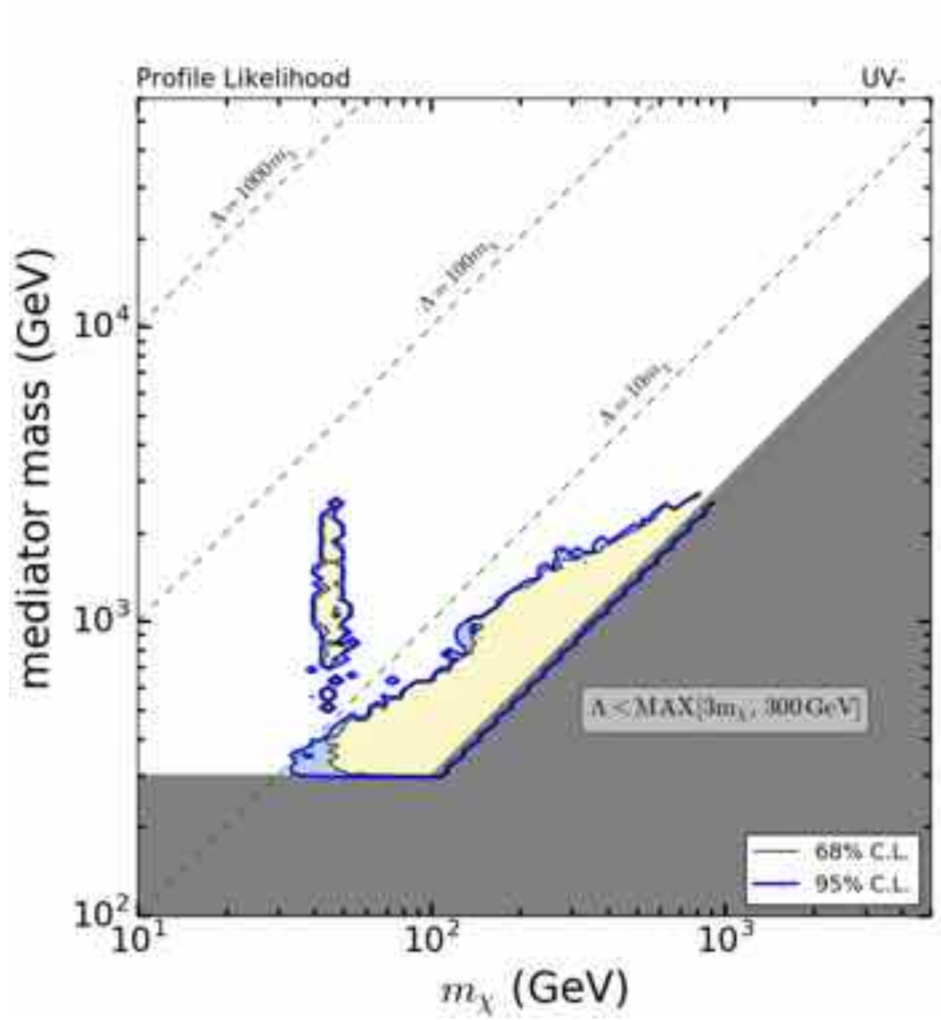
Signal

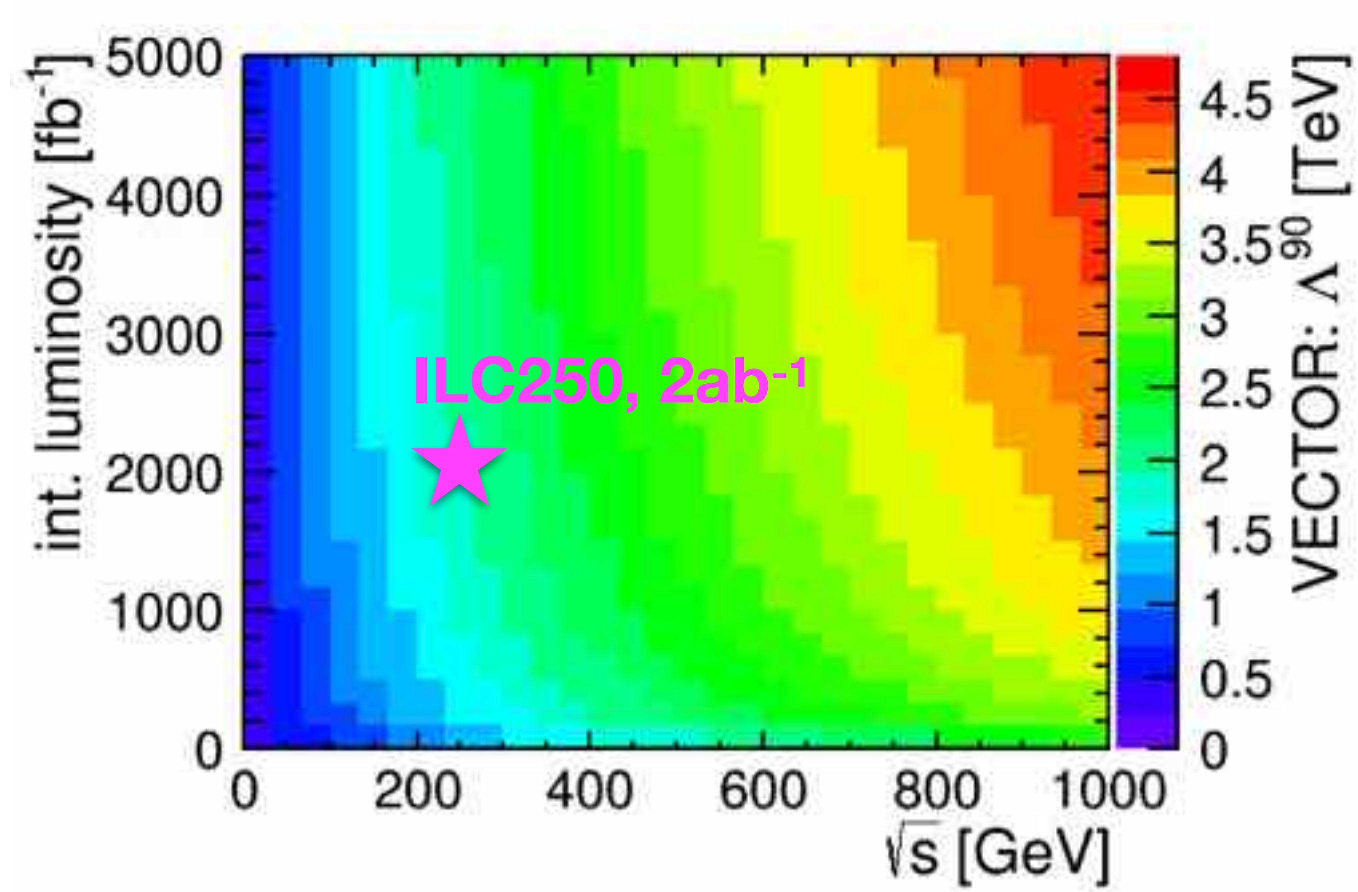


- **Mono-photon process e+e-→χχγ**
  - ILC can probe energy scale Λ
    - up to 2TeV @250GeV
    - up to 3TeV @500GeV

BG







arXiv:1702.05377

m_χ<120GeV can be explored by ILC250

SUSY Particle Search

- **Higgsinos are well motivated**
  - Can be light → still retain naturalness
  - But mass splitting is quite small (a few GeV to sub-GeV) → difficult at LHC
- **Good discovery potential at ILC even for degenerate case!**
- **Good measurement precision also expected**
  - sub-percent level for mass, percent level for cross-section

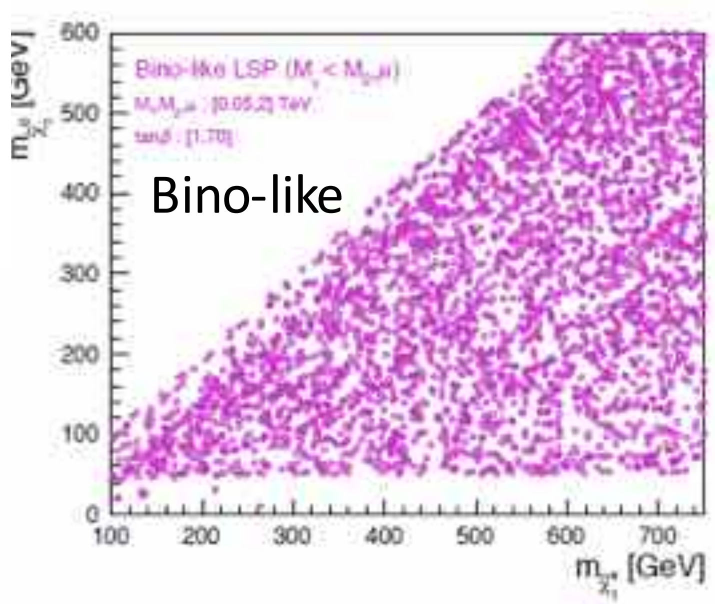
LSP

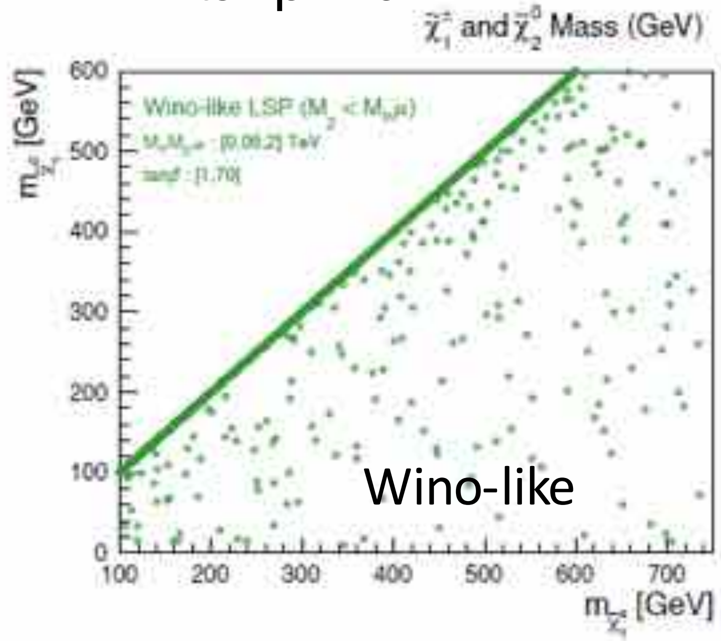
Bino-like $M_1 < M_2, \mu$

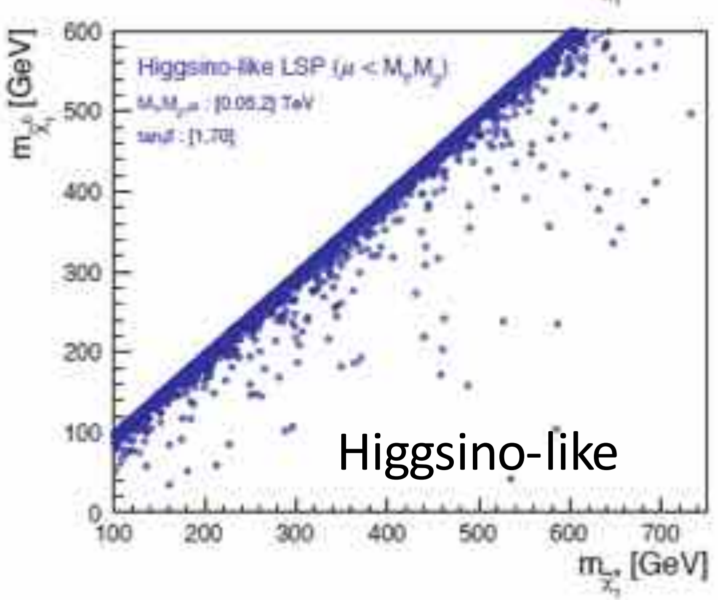
Wino-like $M_2 < M_1, \mu$

Higgsino-like $\mu < M_1, M_2$

(M_1, M_2, μ, $\tan\beta$) point is randomly chosen $0.05 < M_1, M_2, \mu < 2$ TeV, $1 < \tan\beta < 70$



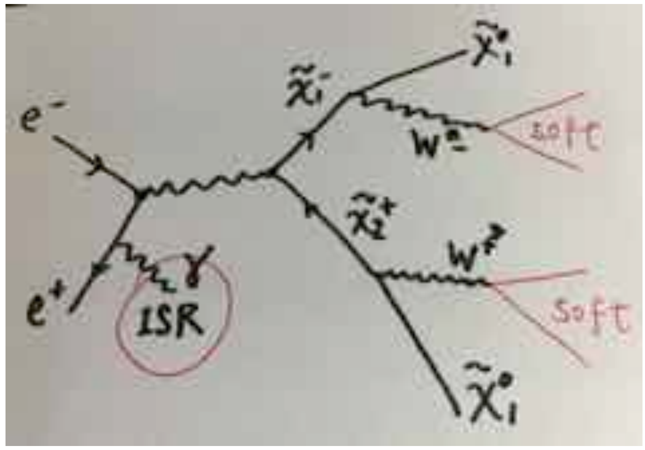




$$e^+e^- \rightarrow \tilde{\chi}_1^+ \tilde{\chi}_1^- \gamma$$

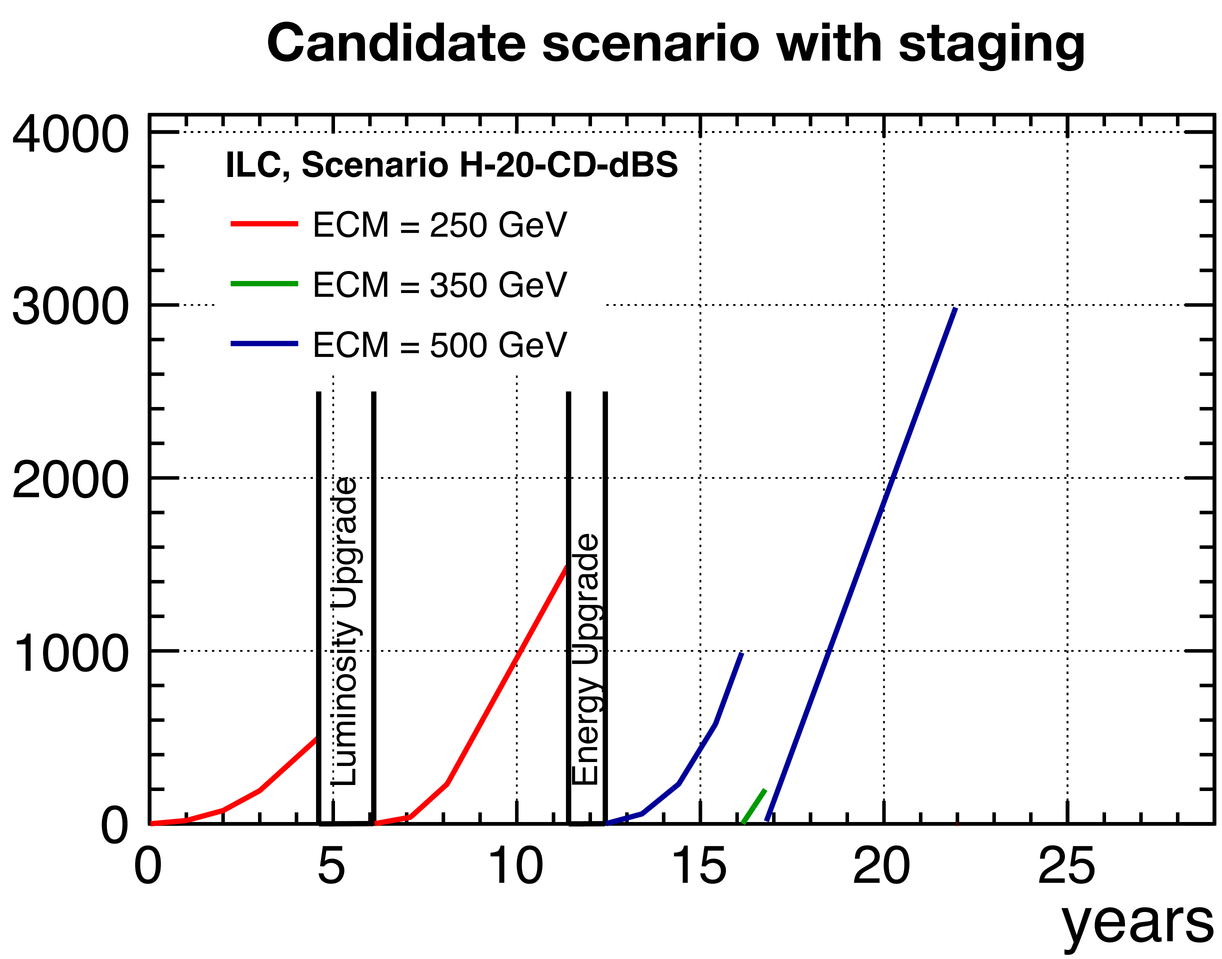
$$e^+e^- \rightarrow \tilde{\chi}_2^0 \tilde{\chi}_1^0 \gamma$$

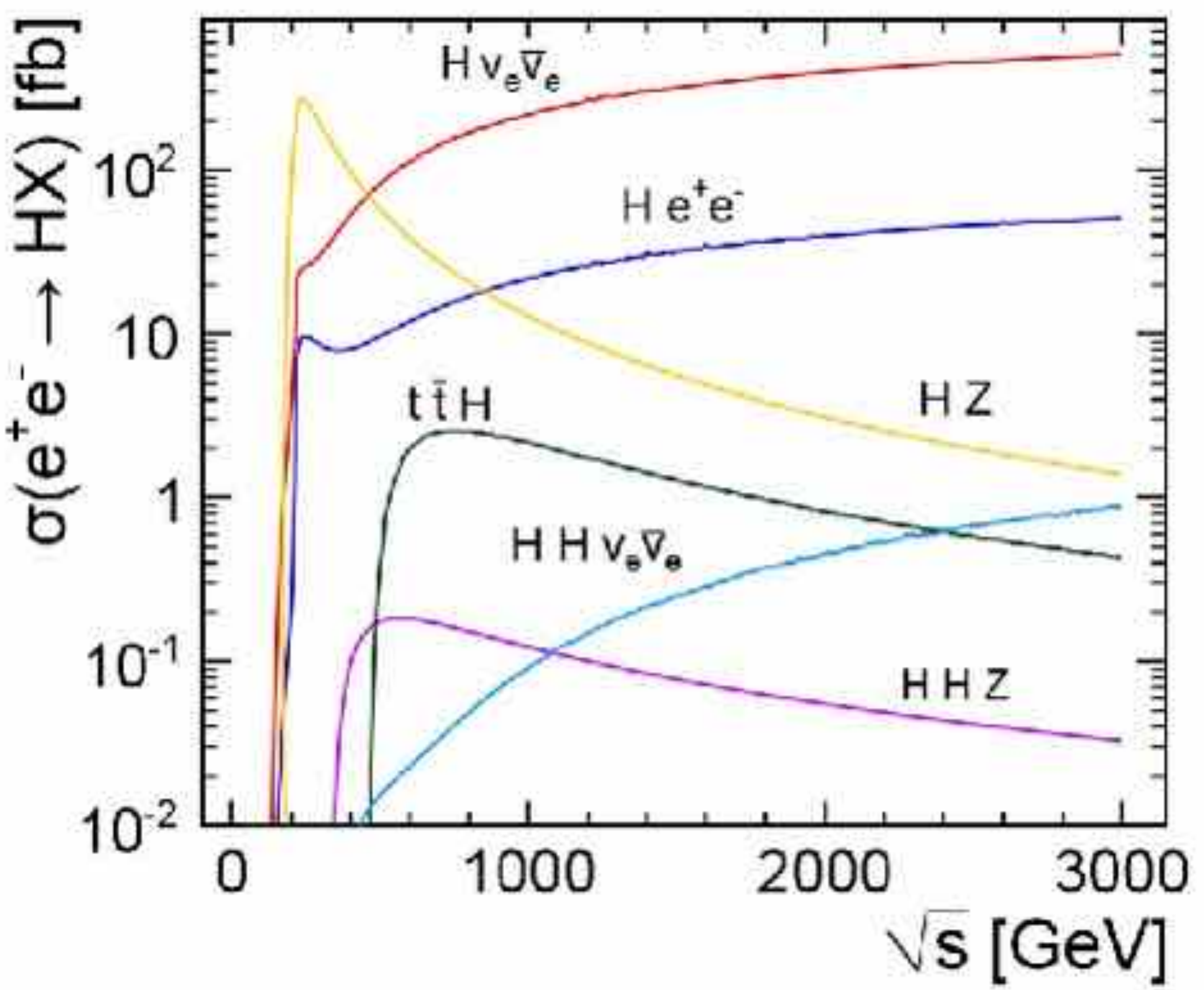
ISR photon + soft particles



Physics beyond ILC250

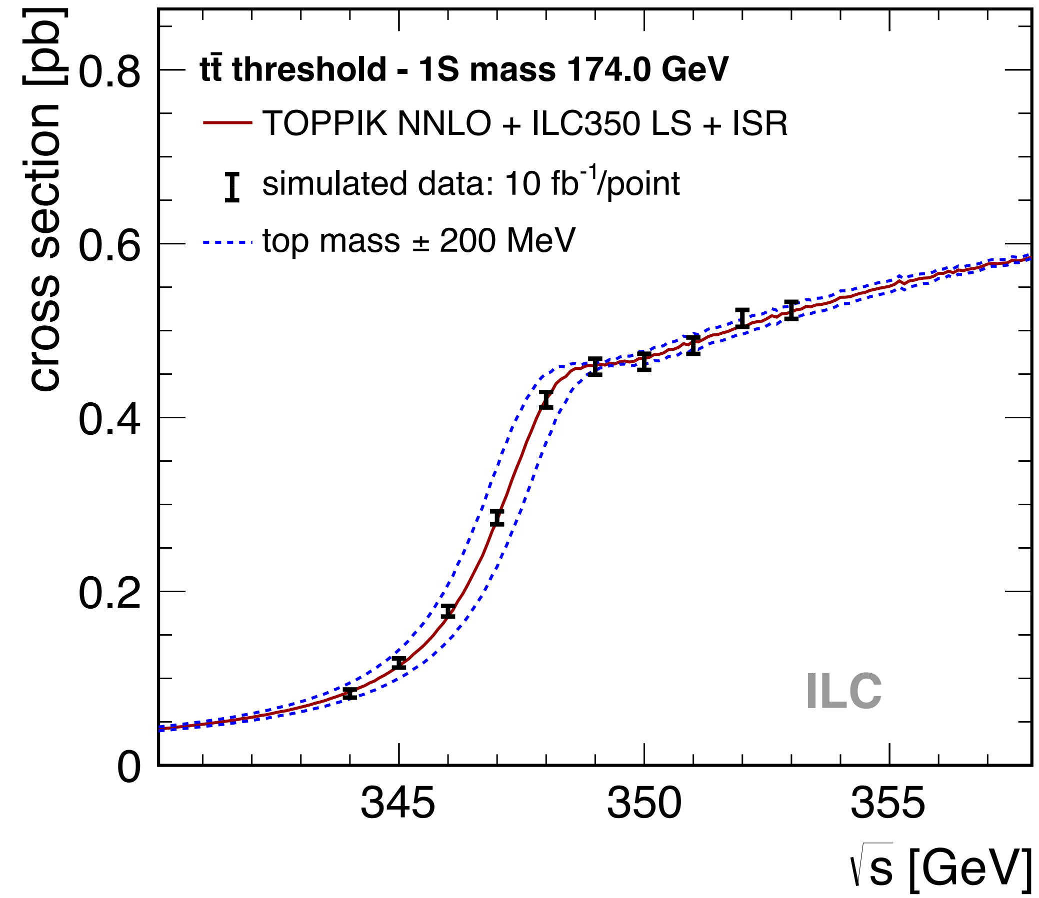
- **Energy extendability is an excellent asset of ILC!**
  - Longer linac
  - Higher field gradient with advancement of accelerator technology



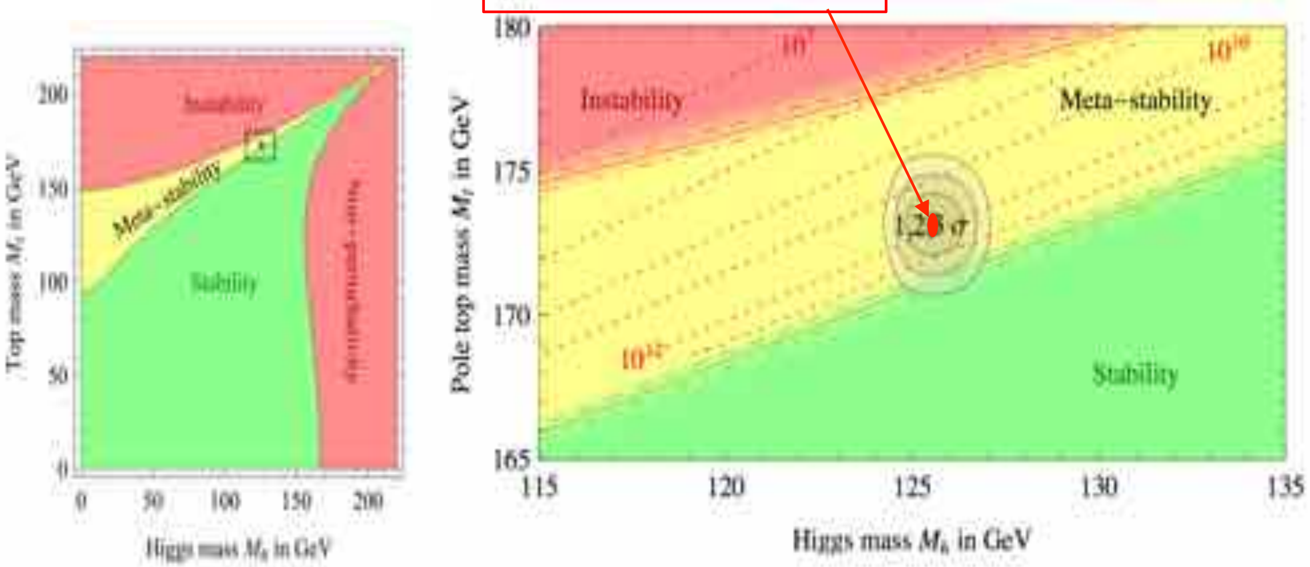


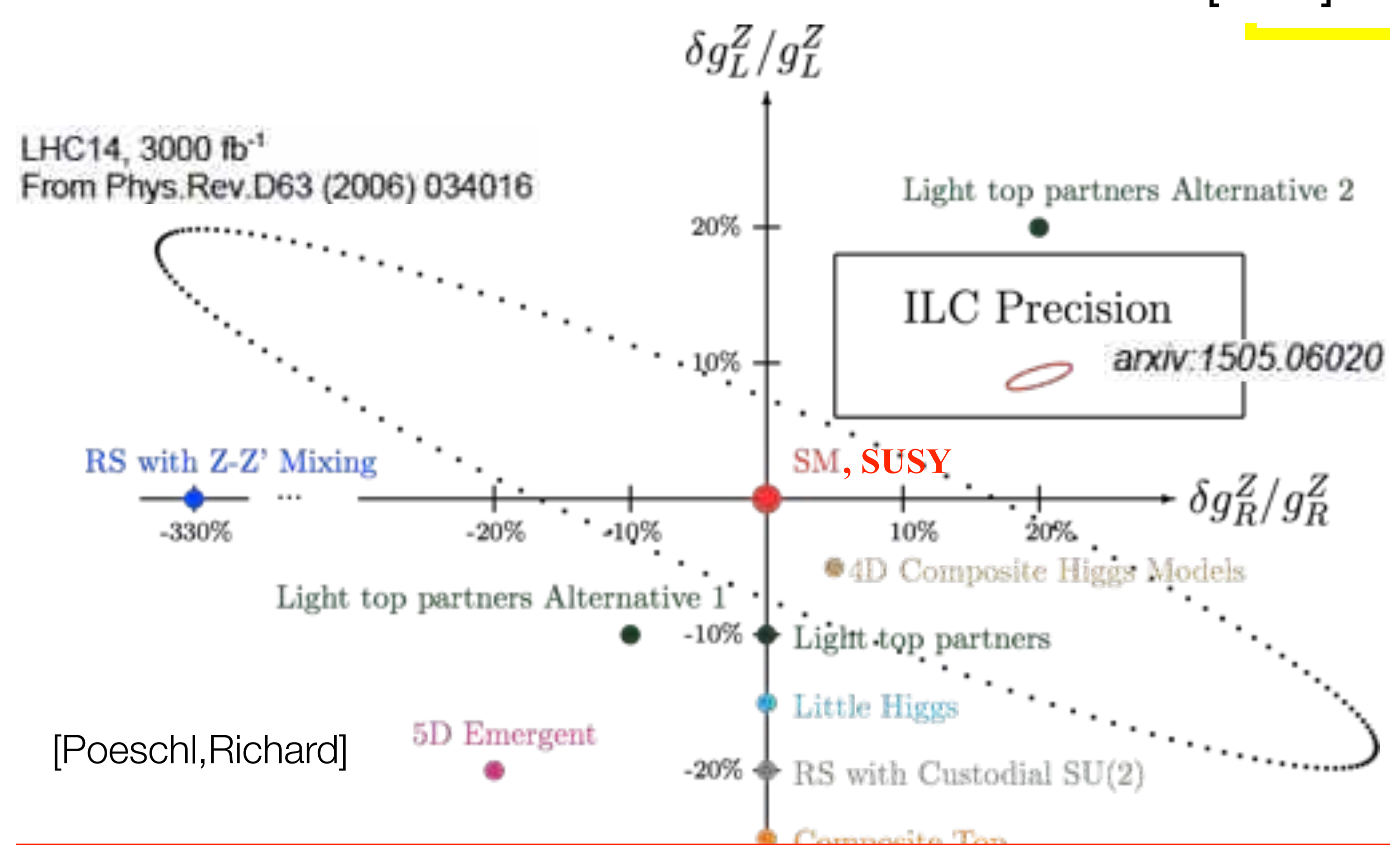
Top Physics above 350GeV

- **Precise top measurements above top pair production threshold**
  - Top quark mass (1S) to 40MeV
    - Useful input to GUT, vacuum stability
  - Top EW couplings at 500GeV
    - Model discrimination (composite top, extra dimension,…)
    - Probe new physics scale ~20TeV



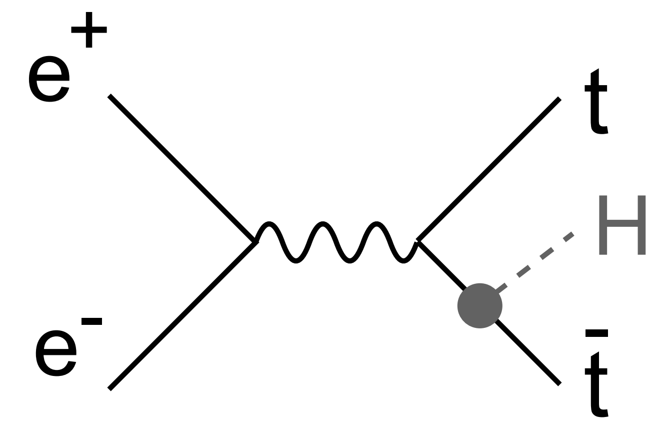
$\Delta M_t(1s)$=50MeV
ΔM_H=30MeV

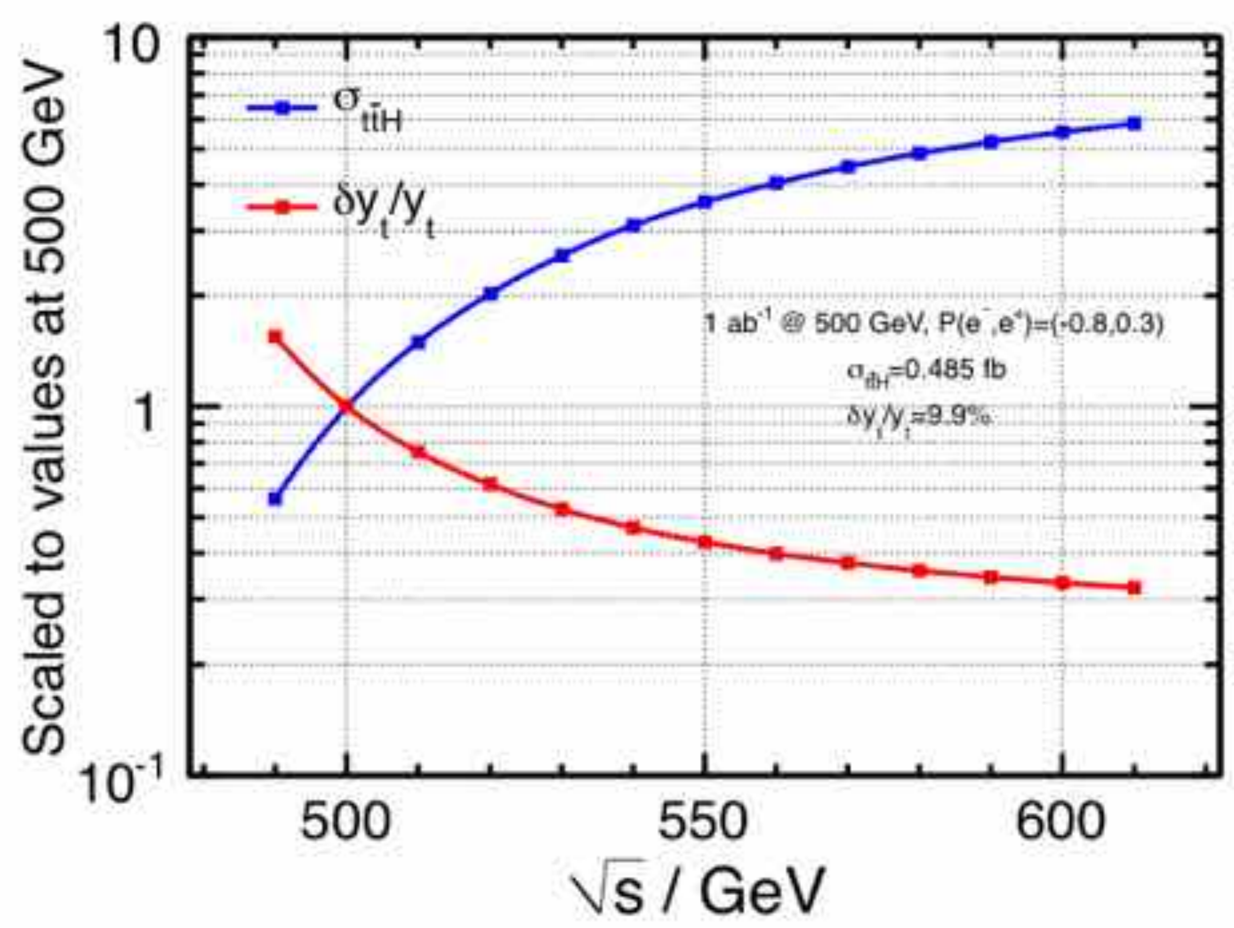




Top Physics above 350GeV

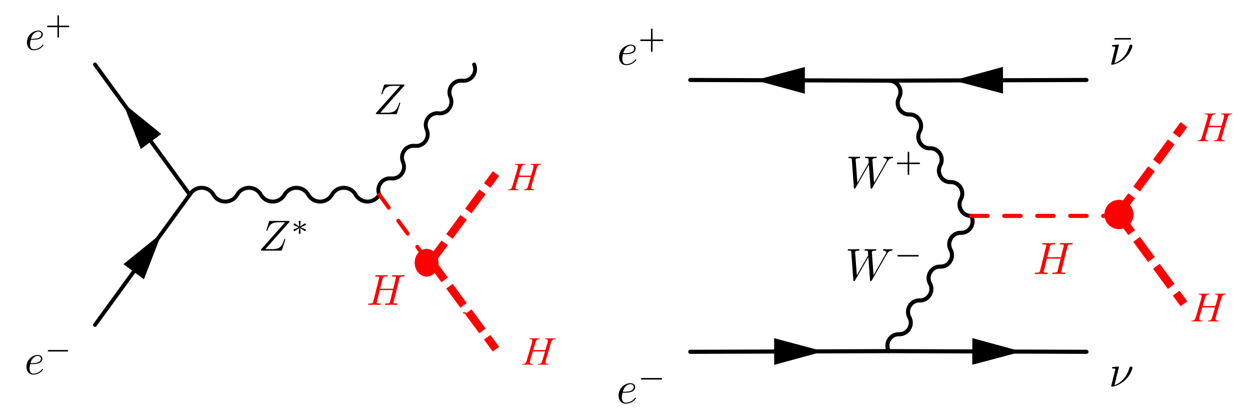
- **Top Yukawa coupling**
  - $E_{cm} > 475$GeV
  - Precision δy_t
    - 6.3%(2.5%) at 500(550) GeV
    - 2% at 1TeV, 4ab^{-1}
    - Probe new physics scale ~20TeV

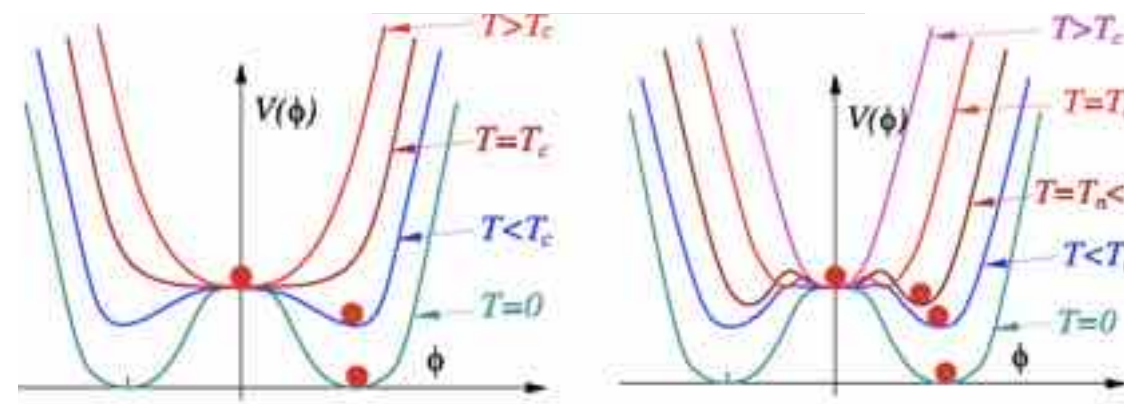




Higgs Self-coupling

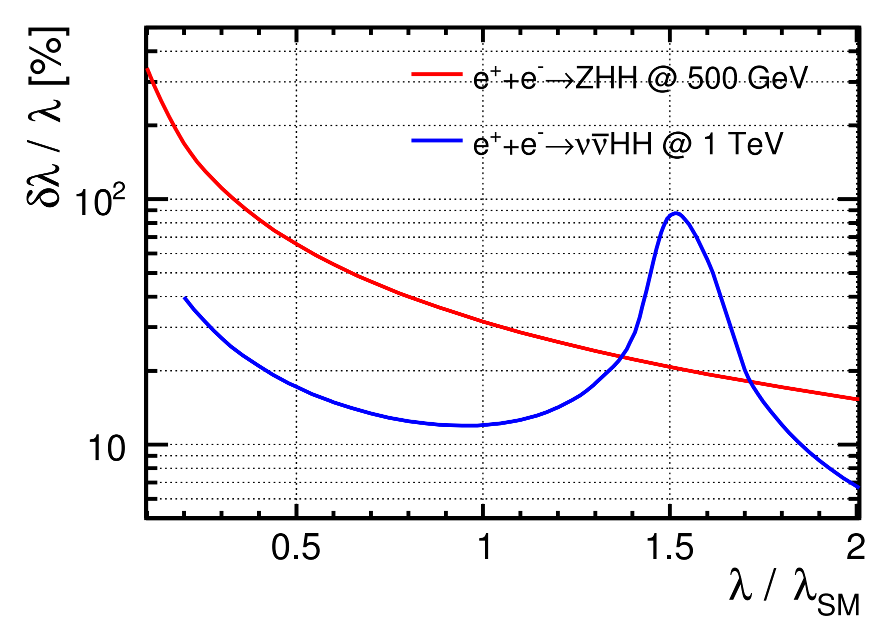
- **Measurement of triple Higgs boson self-coupling via ZZh, ννhh**
  - Shape of Higgs potential
    - Nature of EWSB
    - EW Phase transition (1st order or 2nd order?)
    - Need a strong first-order EW phase transition for EW baryogenesis
- **Very important, but quite challenging**
  - Small cross section (0.2fb for Zhh at 500GeV)
  - Multi-jet final states
  - Interfering diagrams
- **Expected precision**
  - 27% at ILC 500GeV, 4ab^{-1}
  - 19% at CLIC (1.4TeV, 1.5ab^{-1} + 3TeV 2 ab^{-1})
  - Analysis still improving aiming at O(10)%
  - Strongly depends on value of λ/λ_{SM}
- **Large enhancement in many BSM models up to ×1.5-3**





2nd order transition

1st order transition



- Introduction
- Key Technologies for ILC
- Physics Case for ILC
- Status and Plan
- Summary

Progress in Project Promotion

- Official investigation by Japanese government (MEXT) is in progress after the recommendation of Science Council of Japan
  - ILC advisory panel was setup by MEXT in 2014 with four working groups to discuss possible issues of ILC
    - “Particle and Nuclear Physics”, “TDR validation”, “Human resources”, “Organization and management”
- Federation of Diet members for ILC, industries (AAA) and local governments strongly support ILC
- MEXT and DOE set-up “Discussion group” and start cooperative R&D on ILC cost reduction
- Governmental discussions will be expanded to Europe and Asia
- Started serious discussion on staged execution of project, starting as “Higgs factory” at 250GeV
  - Studies on physics case for ILC250 by LCC physics working group (arXiv: 1710.07621) and Japanese HEP community (arXiv:1710.08639)
  - New statement from Japanese HEP community in July 2017
  - LCC study on ILC machine with staging scenario (arXiv:1711.00568)

Report by the Committee on the Scientific Case of ILC Operating at 250 GeV as Higgs Factory

arXiv:1710.08639

- **The committee members consist primarily of members of the ATLAS collaboration, the Belle II collaboration, and theorists. The committee aimed to give an assessment on the physics case of the ILC250 in a way that is independent from the ILC community.**
- **Not an advertisement by ILC community!**

Conclusion of the report:

- In order to maximally exploit the potential of the HL-LHC measurements, concurrent running of the ILC250 is crucial.
- LHC has not yet discovered new phenomena beyond the Standard Model. The ILC250 operating as a Higgs Factory will play an indispensable role to fully cover new phenomena up to Λ~2–3 TeV and uncover the origin of matter-antimatter asymmetry, combing all the results of ILC250, HL-LHC, the SuperKEKB, and other experiments. Synergy is a key.
- Given that a new physics scale is yet to be found, ILC250 is expected to deliver physics outcomes, combined with those at HL-LHC, SuperKEKB and other experiments, that are nearly comparable to those previously estimated for ILC500 in precise examinations of the Higgs boson and the Standard Model.
- The inherent advantage of a linear collider is its energy upgradability. The ILC250 has the potential, through an energy upgrade, to reach the energy scale of the new physics discovered by its own physics program.

A New Statement from Japanese HEP community

- **Scientific Significance of ILC and Proposal of its Early Realization in light of the Outcomes of LHC Run 2**

JAHEP, Jul. 22nd, 2017

"… To conclude, in light of the recent outcomes of LHC Run2, JAHEP proposes to promptly construct ILC as a Higgs factory with the center-of-mass energy of 250 GeV in Japan"

Global Organisation for ILC

FALC
Chair: G. Blair

Funding Agencies
for Large Colliders

ICFA
Chair: J. Mnich

International Committee
For Future Accelerators

The ILC is a truly global project that ICFA is overseeing.

LCB
Chair: T. Nakada

Linear Collider Board
2012-

LCC organized in 2013
New 3-year mandate from 2017

KEK ILC Promotion Office

CLIC Collaboration

Public Relations

LCC
Linear Collider Collaboration

LCC Director
Lyn Evans

Deputy
Hitoshi Murayama

ILC
Associate Director:
Shin Michizono

CLIC
Associate Director:
Steinar Stapnes

Physics & Detectors
Associate Director:
Jim Brau

Report from LCB

- **Conclusions on the 250 GeV ILC as a Higgs Factory proposed by the Japanese HEP community**

Physics studies by the Linear Collider Collaboration Physics and Detector Group [1], and the Japanese Association of High Energy Physicists (JAHEP) [2] show a compelling physics case for constructing an ILC at 250 GeV centre of mass energy as a Higgs factory. The cost of such a machine is estimated to be lower by up to 40% compared to the originally proposed ILC at 500 GeV [3]. The acceleration technology of the ILC is now well established thanks to the experience gained from the successful construction of the European XFEL in Hamburg. One of the unique features of a linear collider is the capability to increase the operating energy by improving the acceleration technology and/or extending the tunnel length. For these reasons, the Linear Collider Board strongly supports the JAHEP proposal [4] to construct the ILC at 250 GeV in Japan and encourages the Japanese government to give the proposal serious consideration for a timely decision.

In recent examples of similar international projects[1], the host country made the majority contribution. A natural expectation would be that the cost for the civil construction and other infrastructure is the responsibility of the host country, while the accelerator construction should be shared appropriately. A clear expression of interest to host the machine under these principles would enable Japan to start negotiations with international partners. It would also allow members of the international community to initiate meaningful discussions with their own governments on possible contributions.

ICFA Statement

- **ICFA Statement on the ILC Operating at 250GeV as a Higgs Boson Factory**

  ICFA, Nov. 8th, 2017

"… ICFA thus supports the conclusions of the Linear Collider Board (LCB) in their report presented at this meeting and very strongly encourages Japan to realize the ILC in a timely fashion as a Higgs boson factory with a center-of-mass energy of 250 GeV as an international project, led by Japanese initiative."

Time Line

Courtesy of S. Michizono

Summary

- **International Linear Collider (ILC) is a proposed electron-positron collider with a well-established design based on matured technologies with excellent features;**
  - Clean environment, well-defined initial state, beam polarisation, energy scan, energy extendability
- **ILC offers unique physics opportunities to address the important questions to which SM cannot answer with**
  - Precision measurements in Higgs, top, and electroweak sectors
  - Discovery potential for new particles
  - Complementary to HL-LHC reach
- **Proposal for phased execution of ILC project for its early realisation**
  - Construct ILC at 250GeV as a Higgs factory in Japan
  - Significant reduction of initial cost by up to 40%
  - Strong physics case of ILC250 has been clarified
  - Positive response everywhere!
- **We should expect some (hopefully positive) action from the Japanese government quite soon, say, within next year 2018.**

Stay tuned!